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## Gas Formation in Abdominal Abscesses: A Roentgen Study<sup>1</sup>

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THE EARLY diagnosis of abdominal abscesses is of considerable clinical importance. Roentgenologic examination is not only valuable in their diagnosis and localization but also in the differentiation from tumors and hematomas.

The roentgenologic features of abdominal abscesses have been described in a small number of excellent studies and will not be the subject of this discussion (1, 2, 3). Generally, the roentgenologic signs depend to a great extent upon the localization of the abscess. Thus, an intraperitoneal abscess may be demonstrable as a space-occupying process displacing the intestinal loops, which usually reveal some degree of ileus in the neighborhood of such an infection. A roentgenologic sign of prime importance is the obliteration of the intermuscular and subperitoneal fat layers of the adjacent abdominal wall, which may be attributed to edema associated with the inflammatory condition.

Abscesses invading or originating in the retroperitoneal space may cause blurring or obliteration of the psoas shadows and frequently lead to swelling of the soft tissues of the flank, which may be demonstrated to advantage on roentgen examination. The changes in the position and motility of the diaphragm associated

with subphrenic, intraperitoneal, and retroperitoneal abscesses are generally known.

These signs, in conjunction with clinical findings, will in many instances be sufficient to establish a diagnosis. Not infrequently, however, the roentgenologic evidence mentioned above may be equivocal or difficult to demonstrate. In children and old people, the subperitoneal and intermuscular fat layers of the abdominal wall may be poorly defined, and marked intestinal distention may obscure the detail of the psoas shadows. On the other hand, large retroperitoneal tumors and hematomas may distort the structures of the abdominal wall and make their fat layers indistinct. Thus, there remain cases in which the differential diagnosis between an inflammatory mass and tumor or hematoma is difficult. Any additional roentgenologic sign, therefore, will be of definite value.

It has been shown by Laurell (1, 2) that abscesses may occasionally contain gas vesicles visible roentgenologically. The roentgen demonstration of gas production in infections caused by *Cl. welchii* and related organisms is now generally recognized as a valuable diagnostic procedure (4). It is surprising, therefore, that in the roentgenologic literature little attention is given to gas formation in infections which

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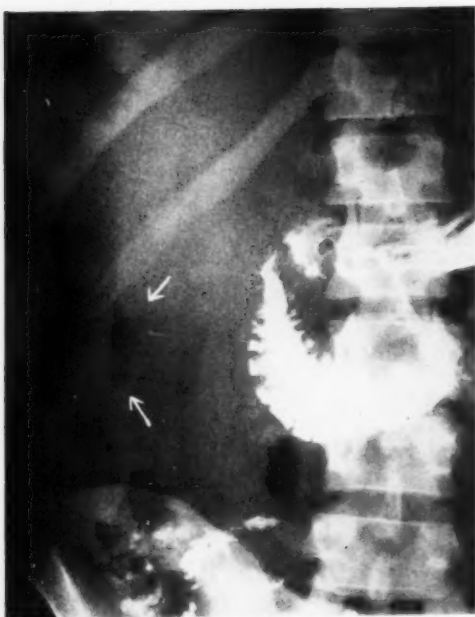


Fig. 1. Case I: Gas formation in large subhepatic abscess.

are caused by other organisms, such as colon bacilli and anaerobic streptococci. Subphrenic abscess is the only condition in which gas formation, due to the colon bacillus, is commonly known to occur (5). There is no doubt, however, that in many subphrenic abscesses the observed gas represents air which has penetrated into the abscess cavity by way of a fistula from the lungs or gastro-intestinal tract. Gillies (6) has observed that in diabetic patients gas formation may occur in retroperitoneal infection due to *E. coli*.

Recently we observed a series of abdominal intraperitoneal and extraperitoneal abscesses in which gas formation was a conspicuous feature. The purpose of this paper is to emphasize that gas formation in abscesses is a valuable roentgenologic sign and may contribute largely to a correct diagnosis.

Following are brief descriptions of 6 selected cases illustrating gas formation in intraperitoneal and retroperitoneal abscesses. The etiologic agents of these infections will be discussed.

#### CASE REPORTS

**CASE I. Intraperitoneal Abdominal Abscess:** C. S., a 35-year-old colored male, was admitted to Grady Hospital because of a large, non-tender mass in the right side of the abdomen. He had been well until eight months prior to admission, when he had an episode of hematemesis and melena. There had been no other symptoms until the day of admission when the patient was seized with a sharp pain in the right lower abdomen which radiated into the upper abdomen and umbilical region.

The temperature on admission was 99.6° F. and the pulse rate was 120. A large mass, measuring about 15 cm. in diameter, extended from the rib margin downward into the flank. This mass was firm, non-tender, and had a smooth surface. The spleen and kidneys were not palpated. The blood count showed a moderate leukocytosis but was otherwise not remarkable. There were no positive urinary findings.

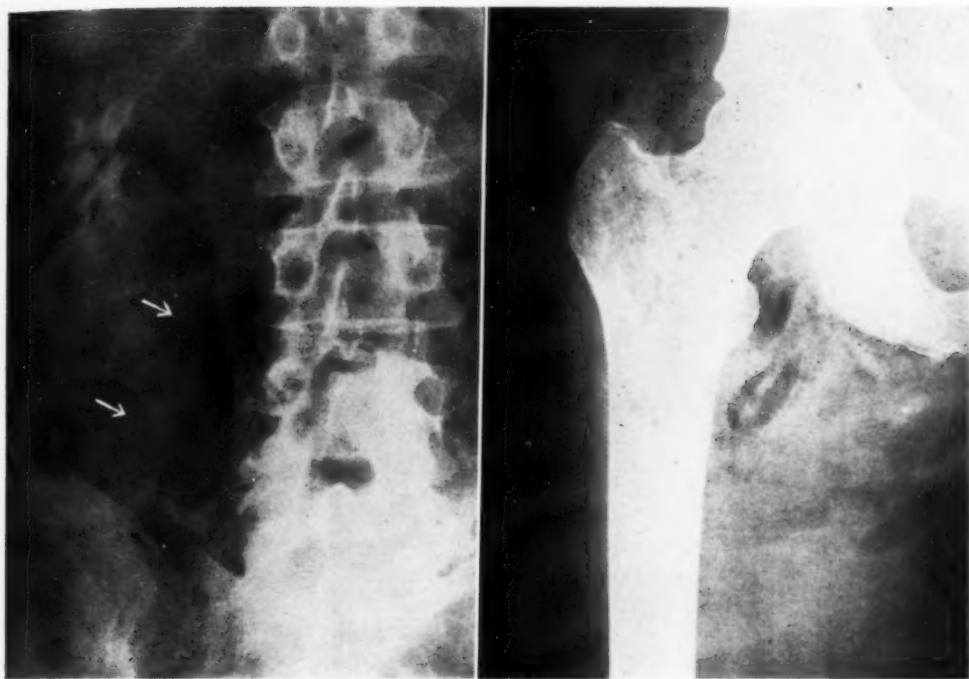
The patient was examined by several members of the staff, who expressed the opinion that the mass represented an intraperitoneal or retroperitoneal tumor.

During the hospital stay the fever ranged between 99.6 and 102.4° F. The patient felt subjectively well and did not complain of pain, though the mass gradually increased in size.

**Roentgenologic Examination:** A film study of the abdomen revealed a large mass throughout the right side, distorting the structures of the abdominal wall without obliterating the fat layers. A retrograde pyelogram made shortly after admission demonstrated that the right kidney was essentially normal but was displaced upward and that the right ureter was deviated toward the spine. A barium enema study several days after admission showed the hepatic flexure markedly depressed by the large tumor. At this time several gas vesicles which had not been present earlier appeared in the center of the mass. A motility series revealed that there were no intestinal loops in the region of the gas formation nor was any fistula present (Fig. 1). On the basis of this information, it was concluded that the mass represented an abscess with gas formation.

**Operative Findings:** The patient was operated on ten days after hospital admission and a large intraperitoneal abscess was encountered at the inferior aspect of the liver. Foul-smelling pus, under considerable tension, was evacuated from this abscess. Aerobic and anaerobic cultures revealed anaerobic streptococci but no gram-positive bacilli. A subsequent gastro-intestinal examination showed a definite deformity of the duodenal cap and it was thought probable that the abscess originated from a perforated duodenal ulcer. Recovery was uneventful.

**Comment:** A 35-year-old male had a large, non-tender mass in the right side of



Figs. 2 and 3. Case II: Retroperitoneal abscess. Fig. 2 (left) shows extensive gas formation within the psoas sheath. Fig. 3 (right) shows extension of the gas formation into the soft tissues surrounding the right hip joint.

the abdomen, believed clinically to represent a retroperitoneal or intraperitoneal tumor. After hospital admission the mass gradually increased in size and the development of gas was noted in its center. This was the deciding factor in establishing the diagnosis of abscess formation. Anaerobic streptococci were cultured from the abscess, which was found to be localized at the inferior aspect of the liver.

**CASE II. Retroperitoneal Infection:** M. G. P., a 57-year-old Negress, was admitted to Grady Hospital because of abdominal pain, fever, weakness, and slight mental confusion. In preceding years she had suffered occasionally from pain in the right lower abdominal quadrant, which had become constant during the last three weeks.

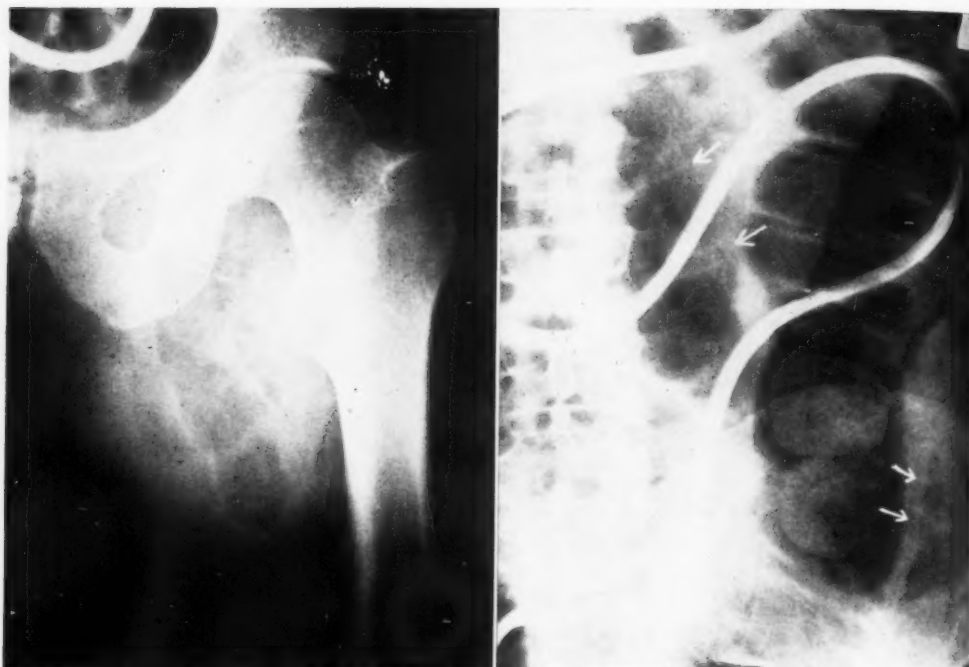
The temperature on admission was 101.0° F. and the pulse rate was 120. The blood pressure was 144/88. There were no remarkable chest findings. A diffuse mass, measuring several centimeters in diameter, was felt in the right lower quadrant of the abdomen. The pelvic examination revealed an erosion of the cervix, which was displaced to the right side. Considerable induration was noticed in the region of the right adnexa.

The urine examination revealed 4-plus sugar, 2-plus acetone, and a trace of protein. The blood sugar one day after admission was 274 mg. per cent. There was no anemia, but there was a leukocytosis of 30,000 with 86 per cent polymorphonuclears.

**Roentgenologic Examination:** Roentgen studies showed considerable edema of the fat layers of the right lower abdominal wall, and the right psoas shadow was poorly outlined. Though the loops of the small and large intestine were greatly distended, a group of small gas vesicles was clearly recognized in the region of the right psoas muscle (Fig. 2). These gas shadows were arranged in a peculiar pattern which did not seem to follow the distribution of intestinal loops. On account of this finding, a diagnosis of retroperitoneal abscess formation with gas formation was made.

In spite of all efforts to regulate the diabetes and combat infection and acidosis, the patient grew steadily worse. On subsequent roentgen examination the gas formation in the retroperitoneal space was seen to be more pronounced and to extend downward to the soft tissues of the thigh, where definite crepitation could be felt (Fig. 3). A pyelogram did not disclose any remarkable findings.

**Operative Findings:** On the fifth hospital day, the retroperitoneal space was surgically explored. The psoas sheath was opened and a moderate amount of dark brownish pus was found in the necrotic muscle



Figs. 4 and 5. Case III. Fig. 4 (left) shows numerous gas shadows in the soft tissues of the thigh, which was tympanic on percussion. Numerous small gas vesicles in the region of the psoas muscle are seen in Fig. 5. There is gas formation at the outer aspect of the descending colon, apparently localized in the retroperitoneal space.

tissue. The infectious process extended upward to the kidney and downward to the iliac fossa. The patient did not improve after operation and died on the ninth hospital day.

Culture of the pus revealed only *E. coli*. No gram-positive bacilli were obtained on anaerobic cultures.

**Comment:** A 57-year-old colored female with diabetes had an extensive retroperitoneal infection extending into the soft tissues of the thigh. The characteristic finding in this case was gas formation, which by aerobic and anaerobic cultures was found to be due to an *E. coli* infection. The gas formation was readily recognized on roentgenologic examination, which made an early diagnosis possible. The origin of the retroperitoneal infection remained uncertain.

**CASE III. Retroperitoneal Infection:** A. W. M., a 57-year-old white male, was admitted to the hospital because of fever and pain in the left lower quadrant of the abdomen. He gave a history of repeated left renal colic and pyelonephritis, for which

he had been admitted to the hospital on previous occasions. On his last hospital admission a left hydronephrosis and ureteral stricture were recognized on pyelographic examination. The patient was treated in the outpatient department with sulfonamides and two ureteral dilatations. Following the second dilatation, he returned to the hospital complaining of slight fever and pain in the left lower abdomen.

There was moderate tenderness in the left lower quadrant, and considerable distention of the intestine was evident on physical examination. The left ureter was again catheterized and urine was obtained from the left kidney. About two weeks after hospital admission, a large swelling appeared at the inner aspect of the thigh, which was tympanic on percussion.

**Roentgenologic Examination:** Roentgen examination showed numerous large gas bubbles in the soft tissues of the thigh, extending upward into the groin (Fig. 4). There were also many small gas vesicles in the region of the psoas shadow and left flank lateral to the descending colon (Fig. 5). It was concluded that the gas formation was due to an extensive retroperitoneal infection.

**Operative Findings:** The swelling in the thigh was aspirated and a large amount of gas with some pus was obtained. Through an incision in the left flank,

a considerable amount of pus and gas was evacuated from the retroperitoneal space. The patient did not improve after this operation and died five days later. The cultures from the aspirated material were overgrown by *B. proteus*.

**Comment:** In a 57-year-old man, suffering from hydronephrosis and ureteral stricture, there developed an extensive retroperitoneal infection with gas formation. This process extended into the soft tissues of the thigh, where gas formation was most pronounced. It was believed that the retroperitoneal infection was most likely due to trauma of the left ureter. The gas formation was demonstrated roentgenologically without difficulty and was a valuable sign in the diagnosis and localization of the infection. The cultures were overgrown by *B. proteus*. This makes it impossible definitely to rule out an infection due to *Cl. welchii* and related organisms. Clinically, this case resembled to a certain extent Case II.

**CASE IV. Retroperitoneal Infection:** L. P., a 42-year-old colored male, was admitted to the hospital with a gunshot wound of the abdomen. An x-ray examination on admission revealed a bullet close to the right wing of the sacrum. The right psoas shadow was obliterated but the right kidney shadow was well outlined.

The heart and lungs were normal on physical examination. A puncture wound was found in the right upper quadrant of the abdomen, which was rigid and tender on palpation. Urinalysis of a centrifuged specimen disclosed 5-10 red blood cells per high-power field but was otherwise not remarkable.

An exploratory abdominal operation revealed three perforations of the small intestine, several perforations of the mesentery, and a tear of the posterior parietal peritoneum. The intestinal perforations were repaired, and a retroperitoneal hematoma was evacuated. Several days after operation, a hectic fever developed and a mass was palpable in the right flank.

**Roentgenologic Examination:** An intravenous pyelogram outlined the right kidney pelvis and calices, which were moderately dilated. The right ureter, which was well demonstrated throughout its upper portion, was displaced anteriorly and to the left. A large mass occupied the entire right half of the abdomen, obliterating the psoas shadow and the fat layers of the right abdominal wall. Numerous small gas vesicles were scattered throughout this mass, which was considered to represent an infected hematoma or urinary extravasation with infection (Fig. 6).



Fig. 6. Case IV: Numerous small gas shadows localized in a large soft tissue mass in the right retroperitoneal space. Right hydronephrosis. Bullet overlying right sacrum.

**Operative Findings:** The retroperitoneal space was again explored one week after admission, and about 1,500 c.c. of foul-smelling urine was evacuated. This was believed to be the result of extravasation from a severed right ureter.

After the second operation, the patient failed to improve. Repeated roentgenologic examination of the urinary tract showed that the large mass in the flank had changed very little in size and that numerous gas bubbles remained in this area. A right nephrectomy was performed, and about 500 c.c. of frothy yellowish pus were evacuated from an abscess at the posterior aspect of the right kidney.

Aerobic and anaerobic cultures at operation contained *E. coli*. No clostridia were grown.

The patient made an uneventful recovery.

**Comment:** After a gunshot wound of the abdomen, a retroperitoneal urinary extravasation occurred in a 42-year-old male. On roentgenologic examination it was possible to predict the presence of infection in the retroperitoneal mass by the conspicuous gas formation. Persistence of the gas formation after draining of extravasated urine disclosed a large abscess in the retrorenal space. *E. coli* was believed to be the pathogenic organism.



Fig. 7. Case V: Gas formation in large abdominal wall abscess. Note resemblance to herniated intestinal loop.

**CASE V. Abdominal Wall Abscess:** S. B., a 60-year-old colored female, was admitted because of fever and a painful mass in the right upper abdomen. She had discovered this mass two weeks before admission and had noticed that it gradually became larger in size. There was no history of gastrointestinal symptoms.

The patient, who was markedly obese, had moderate fever but was in no acute distress. In the right side of the abdomen was a large superficial mass the size of a grapefruit, very tender on palpation. No other masses were palpable.

**Roentgenologic Examination:** The fat layer of the abdominal wall was greatly increased in width. In the region of the superficial mass the fat layer was indistinct and was replaced by a diffuse swelling containing several large gas bubbles (Fig. 7). This gas formation suggested an abscess, though the possibility of a herniated loop of small gut could not be ruled out.

**Operative Findings:** Surgical exploration of the abdomen revealed a large abscess in the subcutaneous fat layer of the abdomen which communicated with another abscess localized below the fascia. Careful exploration of the abscess cavities disclosed no herniated intestinal loops or fistulae. Upon opening the abscess, a large amount of gas escaped

from the incision. Anaerobic streptococci were found on cultures; no clostridia were obtained. The patient made an uneventful recovery.

**Comment:** A 60-year-old female had a large abscess of the abdominal wall, the etiology of which remained unknown. On roentgenologic examination a large amount of gas was demonstrated in the abdominal abscess. Anaerobic streptococci were believed to be the causative organisms in the development of infection and gas formation.

**CASE VI. Abdominal Wall Abscess and Intra-Abdominal Abscess:** L. M., a 39-year-old colored female, was admitted to Grady Hospital because of abdominal pain and a mass in the right lower quadrant of the abdomen. Three weeks before admission she suddenly became ill with cramping pain, nausea, and vomiting. These symptoms subsided rapidly, but some aching remained throughout the lower abdomen. About two weeks before admission a mass was noticed in the right lower abdomen, which gradually increased in size.

The temperature on admission was 99.2° F. A large, bulging, firm, tender mass, about 8 cm. in diameter, was palpated in the right lower quadrant of the abdomen. The white blood count showed a moderate leukocytosis. Urinalysis was not remarkable.

**Roentgenologic Examination:** An anterior-posterior film of the abdomen disclosed a poorly circumscribed mass in the right lower abdomen, displacing distended loops of small and large intestine. The subperitoneal and intermuscular fat layers of both flanks were well outlined and not distorted. An oblique view of the abdomen revealed that the bulging mass was located superficially and contained a small number of gas vesicles (Fig. 8). The subperitoneal fat layers in the region of the abscess were obliterated.

**Operative Findings:** The abdominal mass was incised and about 300 c.c. of foul-smelling pus were obtained. Exploration of the abscess cavity, which was located in the abdominal wall, disclosed a perforation in the posterior rectal sheath connecting with a large intraperitoneal abscess, which was likewise drained.

Recovery was uneventful.

**Comment:** A 39-year-old female had an abdominal-wall abscess which was most likely the result of a perforated appendiceal abscess. A film study in the anterior-posterior view failed to reveal obliteration of the peritoneal fat layers of the flank. In an oblique view superficial localization

of the abscess was demonstrated. Several gas vesicles were localized within the abscess. Unfortunately, bacteriologic studies were not done in this case.

#### DISCUSSION

**Bacteriologic Considerations:** There is no doubt that most gas infections in man are caused by members of the group of spore-bearing gram-positive rods, such as *Cl. welchii*. Gas formation due to other organisms, however, especially in conjunction with intraperitoneal and extraperitoneal infections, seems more common than is generally appreciated.

Though infection and gas formation caused by *E. coli* and related organisms were studied at a time when roentgenologic examinations were not yet available, little attention has been paid to this subject in recent years. Thus, the older literature contains reports of *E. coli* infections in conjunction with gaseous gangrene of the foot (7), retroperitoneal phlegmon (8), and paravesical infection (9). More recently Olsson (10) observed roentgenologically gas formation due to *E. coli* infection in the kidney pelvis and renal parenchyma. In emphysematous infection of the urinary bladder *E. coli* may be encountered as a causative organism (11). In a case of emphysematous gastritis *A. aerogenes* and *B. proteus* were believed to have taken part in the infection and gas formation in the stomach wall (12).

Extensive gas formation in retroperitoneal infections due to *E. coli* was reported by Gillies (6) in diabetic patients. The high dextrose level of the tissue fluids in diabetes apparently facilitates both infection and gas formation by *E. coli* and related organisms. Hitschmann and Lindenthal (13) had previously made a similar observation and postulated that gas formation due to *E. coli* in human tissue would occur only in the presence of diabetes. This conception was refuted by numerous clinical and experimental observations (8, 9, 14, 16) in which gas formation due to *E. coli* was demonstrated in non-diabetic individuals.



Fig. 8. Case VI: Small group of gas vesicles in abdominal wall abscess.

It is not commonly known that the group of anaerobic streptococci may also form gas in human tissues. Colebrook and Hare (15) demonstrated that anaerobic streptococci were abundant gas formers on suitable culture media. Marwedel and Wehrsig (16) in a clinical observation described two cases of gas infection of the lower extremities due to anaerobic streptococci. These authors state that anaerobic streptococci without association with other organisms, and in the absence of a preceding suppuration or necrosis, may produce gas gangrene similar to that due to *Cl. welchii* and related organisms. Recently MacLennan (17) made similar observations and asserted that streptococci may infect muscle and produce a condition which is likely to be mistaken for gas gangrene.

From these observations it may be seen that gas formation in infectious processes

is by no means an exclusive manifestation of *Cl. welchii* or other spore-bearing gram-positive bacilli. As illustrated in our cases, conspicuous gas formation may be demonstrated on roentgenologic examination in infections due to other organisms, such as anaerobic streptococci, *E. coli*, and related bacteria. It seems important for the clinician and roentgenologist to be familiar with this fact in view of the proper classification, treatment, and prognosis of infections with gas formation.

**Roentgenologic Diagnosis:** The roentgenologic diagnosis of gas formation is dependent to a great extent upon the localization of the inflammatory process. Gas formation in the retroperitoneal space may have a characteristic appearance. The gas vesicles may occupy the fascial planes, outlining the borders of the retroperitoneal structures, as the kidneys, adrenals, and muscle groups. Gas vesicles localized within the psoas muscles are usually arranged in long rows parallel to the course of the muscle fibers. This also holds true for infections which spread from the retroperitoneal space into the soft tissues of the thighs and groin, where the gas vesicles may follow the course of fascial planes and muscle bundles.

Gas formation in intraperitoneal abscesses is recognized with more difficulty. The differential diagnosis between bacterial gas formation in abscesses and gas localized in intestinal lumina will in many instances be facilitated by the observation that the gas bubbles in the abscess are in an area which is not usually occupied by intestinal loops. For example, in Case III (Fig. 5), gas vesicles were seen in the lateral aspect of the descending colon, where small intestinal loops are not usually seen. Also, it may be possible in many instances to identify intestinal loops by their characteristic segmentation and mucosal pattern. Administration of contrast medium by mouth will outline the entire gastro-intestinal tract and help to rule out the presence of a fistula. It may be exceedingly difficult to differentiate between gas vesicles localized in an abscess

of the abdominal wall and intestinal loops herniated into the abdominal wall. The intestinal loops are often sharply outlined and may maintain some of their characteristic pattern, whereas gas formation in an abscess is characterized by numerous small vesicles which are frequently arranged in clusters.

Small gas shadows in abscesses may be easily overlooked, but an examiner who is aware of this phenomenon will recognize them with less difficulty and confirm their presence by repeated examinations in oblique, recumbent, and upright views and by stereoscopic studies. The observation of gas formation is more helpful than is generally appreciated, and every effort should be made to utilize this phenomenon in roentgenologic diagnosis.

#### SUMMARY AND CONCLUSIONS

1. Gas formation in abdominal abscesses does not necessarily indicate the presence of an infection due to *Cl. welchii* and related bacteria but may be caused by a variety of organisms.

2. In a small series of cases *E. coli*, *B. proteus*, and anaerobic streptococci were found in intraperitoneal, retroperitoneal, and abdominal-wall abscesses.

3. Various roentgenologic signs of abdominal abscesses are briefly discussed, and difficulties in their demonstration and evaluation are mentioned.

4. Gas formation in abscesses is a valuable roentgenologic sign of infection which may be of considerable aid in differentiating them from tumors and hematomas.

5. It is demonstrated that in occasional cases gas formation is the most significant roentgenologic sign of an abdominal abscess. It is suggested that in the interpretation of roentgenograms particular attention be paid to this phenomenon.

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# Lymphoepithelioma<sup>1</sup>

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THE RADIOLOGIST who is called upon to treat squamous-cell carcinoma of the face, mouth, and jaw, often after hopeless metastases are present in the regional lymph nodes, welcomes the occasional radiosensitive tumor arising in this area. The lymphoepithelioma is a neoplasm of this type. Its unpredictable metastases add to its interest and its radiosensitivity serves as a challenge to search out and treat the secondary lesions as they occur. Unfortunately, as is so often true in cases referred to the radiologist, the metastases may be in such a location that no amount of radiation will produce regression. Not infrequently the discovery of the metastases antedates the demonstration of the primary tumor. Its discovery may be not only difficult but impossible.

Not until recent years has primary carcinoma of the nasopharynx been considered of frequent occurrence. In 1904, Laval (31) was able to find only 27 instances of primary carcinoma in this location recorded in the literature. Gatewood (21), in 1916, found 26 more reported cases and added 2 of his own. It was suggested by this authority that the difficulty in distinguishing primary nasopharyngeal carcinoma from sarcoma and endothelioma might perhaps account for the small number of cases on record.

New (36) reported 79 cases of malignant tumor of the nasopharynx, including only epitheliomas and lymphosarcomas, all seen in a six-year period prior to 1922. He concluded that such tumors were much more common than had previously been believed. Ewing (15), in 1929, reported and classified 300 cases of intra-oral cancer. Two hundred were of the tonsil and 100 of the nasopharynx. Gardham (20), in 1929, described a group of nasopharyngeal tu-

mors infiltrating about and into the base of the skull. In his opinion these were endotheliomas. In 1931, New (37) was able to present a series of 246 malignant tumors of the nasopharynx. Dunlap (12), Digby (10), and Green (22) report a high incidence of nasopharyngeal neoplasms in Orientals. In a six-year period of private practice Dunlap saw 16 cases in Chinese patients. The tumors all arose at the nasopharyngeal opening of the eustachian tube and in the tube itself. During this period he saw no lesions of this type in his other private patients, most of whom were Caucasians. He reported most of his cases as transitional-cell carcinomas.

In 1921, Reverchon, Reçaud and Coutard (42, 44) were impressed with the radiosensitivity of a group of tumors occurring in the nasopharynx. These tumors had a peculiar cell structure consisting of a close and constant relationship between the epithelial and lymphoid elements. The resemblance to normal lymphoepithelial tissue led the authors to apply the name "lympho-épithéliome" to this group. In the same year Schmincke (46), working independently, reported radiosensitive tumors arising in the same area and showing a similar microscopic picture. Jovin (28), in 1926, published a series of cases from the Radium Institute of Paris, describing the clinical, pathological, and radiosensitive characteristics of the disease. He agreed with opinions previously expressed, that these tumors arise from lymphoepithelium occurring normally in the nasopharynx. The widespread metastases, high degree of malignancy, and susceptibility to radiation were emphasized as the essential clinical features.

Quick and Cutler (39), in 1925 and again in 1927 (40), pointed out that from a group

<sup>1</sup> From the University of Kansas Hospital, Kansas City, Kansas. Read by title at the Thirty-first Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 9-10, 1945.

of epidermoid carcinomas a few showed a high degree of radiosensitivity and a peculiar histologic structure. These tumors presented transitional-cell characteristics. They were found at the base of the tongue, in the tonsil, or in the eustachian canal. Histologically, they had been variously classified as atypical epidermoid carcinomas, anaplastic carcinomas, embryonal tumors, lymphoepitheliomas, and transitional-cell carcinomas. It was felt that many cases reported as reticulum-cell sarcoma and lymphosarcoma were likely of this cell type. Obviously these authorities were not ready to recognize the lymphoepithelioma as a specific tumor, separate and distinct from transitional-cell carcinoma, which in location and clinical behavior is almost if not entirely identical with the lymphoepithelioma.

Ewing (15), in his masterful discussion of radiosensitive carcinomas in 1929, makes a definite microscopic distinction between the transitional-cell carcinoma and the lymphoepithelioma. Among his 300 cases involving the tonsil and nasopharynx were 15 lymphoepitheliomas and 51 transitional-cell carcinomas. He admitted that he found it impossible always to make a definite differential microscopic diagnosis between the two tumors. In his study of similar cases seen by Lacassagne in the Radium Institute of Paris, he found cases that were called lymphoepithelioma which he would have called transitional-cell carcinoma or schneiderian carcinoma. In more recent years, case reports of this interesting tumor have been recorded by many writers (5, 17, 33, 2, 23, 3, 25, 4, 1, 38, 30, 47, 45, 35, 11). Fitzhugh (18), up to 1938, found 150 cases reported in the literature as lymphoepithelioma and added 5 of his own.

The common location of the primary lymphoepithelioma is the nasopharynx, pharyngeal tonsil, and base of the tongue. One case primary in the parotid has been reported (16). The primary lesion is usually small. It presents on inspection a finely granular surface which early shows no ulceration. It may give the appearance

of having arisen from deeper structures, with fixation secondarily of the mucous membrane over the surface. Quick and Cutler (40) described the lesion as being diffuse, in some instances extending around the pharyngeal ring and involving the mucous membrane of the base of the tongue, tonsils, and posterior pharynx, with superficial ulceration and bilateral cervical adenopathy. In none of our cases was such extensive involvement by the primary tumor seen. Occasionally a very large tonsillar tumor is encountered, extending across the mid-line, interfering with breathing and swallowing. The primary tumor does not tend to bleed and for this reason is often overlooked. Arising in the eustachian canal, as it often does, it may never be found. Enlarged cervical lymph nodes are usually present and may be the first evidence of a malignant tumor.

The microscopic picture has been described fully by such pathologists as Jovin (28), Ewing (15), Cappell (6), and Wahl (50). As a radiologist, I accept their descriptions and quote freely the findings recorded by them. Ewing emphasizes the fact that the histologic structure is not always the same. Jovin describes sheets of large delicate cells, with large vesicular nuclei and indefinite cell borders, infiltrated with leukocytes. In Schmincke's case the cell groups were more broken up. The cell walls were indefinite and the admixture of lymphocytes was so abundant that epithelial cells were identified with difficulty. This process approaches the structure of a lymphosarcoma. Squamous and spindle cells are entirely lacking. Because of the indefinite cell membrane and faint staining, the impression may be gained of a syncytial mass. The cells contain large clear nuclei with a prominent nucleolus, which often shows mitotic figures.

Cappell (6) separates the lymphoepitheliomas into two main groups, the Regaud-Jovin type and the Schmincke type. The former consists of strands of epithelial cells with large pale-staining nuclei and poorly delineated cytoplasm embedded in a stroma more or less rich in

lymphocytes. The nuclei are usually round or oval, rather poor in chromatin, and contain one or two nucleoli. The outline of the individual cells is indistinct, and no intercellular bridges can be demonstrated. In many places the epithelial cells appear in broad sheets, lying in a well formed fibrous stroma, while in other areas they are seen as thin strands penetrating deeply into the tissues of the palate and nasopharynx. The individual cells may be closely packed together or may form a loose type of architecture heavily infiltrated by lymphocytes.

The second group, to which the name of Schmincke has been applied, consists of irregular anastomosing trabeculae of ill defined cells with large vesicular nuclei. In many places the appearance of epithelial columns is lost and the cells become dissociated from one another, giving rise to a mass of loosely packed round, oval, or polyhedral cells. In some places these elements form the bulk of the tumor, but in other parts they are separated by dense lymphocytic infiltration which tends to isolate them from one another and renders recognition of individual cells difficult.

To the author the difference in the two pictures is slight. It seems to me, as I study the descriptions, that the Schmincke type is characterized by greater lymphocytic infiltration than is the Regaud-Jovin type. Cappell concludes that probably the Regaud type arises from the schneiderian membrane. It has not yet been decided whether or not, when it arises in the tonsil region, it is made up of hyperplastic tonsillar reticulum or represents a permeation of the tonsil by neoplastic cells.

Harvey, Dawson, and Innes (24) point to the fact that lymphocytic deposits in the mucosa and submucosa are characteristic of the embryonal entodermal tract and persist to some extent in the adult. When an epithelioma arises in such a structure or penetrates such a tissue, it seems only natural that the lymphoid tissue should still retain its original relation to the epithelium. These writers prefer to classify all of the tumors which are not of definitely squamous-cell origin as epidermoid or

transitional-cell carcinoma. In their opinion, neither architecture nor cytology is sufficiently distinctive to justify a separate classification as lymphoepithelioma.

Several theories relating to the origin of this tumor have been advanced. The least acceptable, by most pathologists, is the embryonal theory. Hoffmann (26), after studying 111 cases reported by 33 observers, concluded that the tumor has a branchiogenous origin and is dependent on congenital anomalies. It is assumed that islets of germinal tissue lie dormant for years and begin to grow, due to factors unknown.

Quick and Cutler (40) suggest that since transitional epithelium is found at the base of the tongue, in the folds and sinuses of the larynx, in the nares, and in the crypts of the tonsils, it would not be unusual to find tumors of the same cell type arising there. They also suggest that these tumors arise from squamous cells which in their growth fail to develop spines, lose their adult characteristics, undergo aplasia, and become changed to an undifferentiated rounded or polyhedral form. They then grow diffusely as anaplastic tumors.

Regaud (42), Schmincke (46), Jolly (27), Mollier (34), Ewing (14), and others, accept the theory that the epithelium covering the lymphoid deposits of the nasopharynx, especially of the tonsil and base of the tongue, are fundamentally modified by a symbiosis with lymphocytes, and that this tissue should be regarded as a specific tissue, lymphoepithelium. This lymphoepithelial tissue was recognized and described by Retterer (43) as early as 1886. It was also discussed by Stöhr (48) and Jurisch (29) prior to the description of the tumor by Schmincke and Regaud. Origin from this lymphoepithelial tissue seems to be the most popular and to the author the most reasonable theory. Its opponents assume that lymphocytes may enter a tumor secondarily. It has been shown by Derigs (9), Cutler (41), and others, that bone and visceral metastases present the same cell type, including lymphocytic symbiosis or infiltration, as does the pri-

mary tumor. This seems to be a logical argument in favor of a specific tissue origin.

#### SYMPTOMS

Trotter (49), in 1911, discussing certain nasopharyngeal tumors which he assumed usually to be endothelioma, but which, because of their manner of metastasis, may have been of the type under discussion, outlined the classical symptoms. These include the triad of deafness, neuralgia, and lack of normal excursion of the palate. New (36), in 1922, clearly brought to our attention the fact that many symptoms other than a sore throat may be the chief complaint of a patient suffering from a malignant nasopharyngeal tumor. He pointed out the fact that the nasopharynx is in close relationship to the eustachian tubes, to the 2d, 3d, 4th, and 6th nerves, the 2d and 3d division of the 5th nerve, the gasserian ganglion, the sella turcica, the jugular foramen, and the 9th, 10th, 11th, and 12th nerves. Symptoms indicating involvement of any of these structures should immediately suggest a nasopharyngeal neoplasm. This broad field for possible invasion by the tumor suggests that the rhinologist should be called into consultation more often to evaluate deceptive symptoms which may be due to such invasion.

Symptoms described by New are as follows: (a) pain in the eye with or without diplopia; (b) pain in the ear resembling an acute infection or mastoiditis; (c) trigeminal neuralgia; (d) ptosis of an eyelid; (e) enlargement of cervical lymph nodes. Enlargement of the cervical nodes was present in 46 per cent of a later series of 246 cases of malignant nasopharyngeal tumors presented by New (37). In the tumor under discussion enlarged nodes may be the only visible evidence of disease. This has led to a diagnosis of primary endothelioma of the lymph nodes in some cases. Ewing feels that this is a hazardous diagnosis to make, until all possibility of a primary tumor has been eliminated. Ankylosis of the lower jaw due to invasion of the muscles of mastication may make ade-

quate examination of the nasopharynx impossible. This was true in one of our cases (Case 3). Many authorities (13, 7, 51) have stressed the observations of New. Even though lymphoepithelioma is not obvious to the careful examiner, it must be kept in mind when these symptoms are presented.

#### TREATMENT

We were prompted to present this subject to radiologists because of the rather slight mention this tumor has received in radiological literature. Even though the treatment is recognized as entirely in the hands of the roentgen and radium therapist, the major discussion has appeared in the periodicals of the pathologist and otorhinolaryngologist. Crowe and Baylor (8) were among the first to stress the importance of radiation and gave Dr. Curtis Burnam credit for treating their nasopharyngeal tumors. Quick and Cutler (39) reported the effect of radiation on metastatic squamous-cell carcinoma of the cervical nodes. They found that small doses of radiation which had no effect on fully differentiated squamous-cell carcinoma caused rapid and effective regression of the transitional-cell type. Martin and Blady (32) presented an excellent summary of radiation therapy procedure.

If the tumor is in the tonsillar area, we prefer roentgen treatment to application of radium. Through a round portal, 3.5 cm., a dose of 300 r is applied intra-orally every other day. On alternate days 300 r are given to the adjacent cervical area, through a 10 × 10-cm. portal. To the skin area a dose of 3,000 r and to the tonsillar area a dose of 2,000 to 3,000 r is recommended. A half-value layer of 1.9 mm. copper is used.

If the tumor is in the posterior nasopharynx, it has been convenient and satisfactory to insert a radium applicator, in the form of a gold capsule with a 1-mm. wall thickness, into the nasopharynx for a dose of 1,300 to 1,800 mg. hours. The cervical lymph nodes should be given all the radiation that normal tissues will tolerate.



Figs. 1 and 2. Case 1: Photographs of patient made on admission (1) and three months after treatment (2). Cervical node biopsy was reported lymphoepithelioma. A dose of 9,500 r was applied to the left cervical nodes.

Even though this is a radiosensitive tumor, one is not justified in using a small dose. One of our patients was given 7,800 r over the cervical nodes in a period of one year. The dose was administered in four series of treatments. In each case a half-value layer of 1.9 mm. copper was used. We prefer relatively heavy filtration even though the tumor may be superficial.

As in all cases of malignant growth, we can only plead for more accuracy in diagnosis early in the disease. In our experience, distant metastases are not amenable to therapy and failure results. Relief of pain in our one case of bone metastases was far less striking than in similar metastases from carcinoma of the breast.

The patient whose primary tumor is in the tonsillar fossa, where it can be seen early, is fortunate. This, of course, is assuming that he appreciates the significance of the lesion sufficiently to seek aid early. The tumor in the eustachian canal or nasopharynx may never be found even

after distant metastases are present. If the symptoms outlined by New and others present themselves, the patient should be referred to a rhinologist for study. It is only through early diagnosis and rigorous therapy that any of these patients can be saved.

#### CASE HISTORIES

CASE 1 (Figs. 1 and 2): E. W., white male, age 16, was first seen Jan. 4, 1935, complaining of a sore spot behind the angle of the jaw on the left. There had been slight swelling for one year, with recent rapid growth. Other symptoms were headaches, earache, and deafness of the left ear for about a year, and occasional vomiting episodes.

*Physical Examination:* The left pupil was slightly irregular and the vision poor. There was a fixed mass about the size of a small lemon in the upper left cervical chain. On the right was a cervical node 1.0 cm. in diameter, moderately tender. A posterior nasopharyngeal mass could be palpated.

*X-Ray Examination:* On admission no lesion was demonstrable roentgenologically. Two years later there were evidences of lung metastases in the left base and suggestive erosion of the left greater wing of the sphenoid.

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**Pathology:** Biopsy of a left cervical node was reported "lymphoepithelioma."

**Treatment:** From Jan. 5, 1935, to April 9, 1937, a total dose of 9,500 r was given to the left cervical nodes. During the last year of life 2,000 r were given to the anterior and the same amount to the posterior left lung base; 2,000 r were applied to the left lateral skull. The enlarged node in the right cervical area receded promptly after 1,000 r.

The nasopharyngeal mass was treated with radium as follows: A 1-mm. brass capsule was placed in the anterior nasopharynx for a dose of 120 mg. hours; 300 mg. hours was the dose used in the posterior left nasopharynx. The mass rapidly receded, so that breathing through this side became possible.

**Progress Notes:** The patient returned on April 2, 1935, saying that he had felt well until ten days earlier, when his headache returned. His diplopia was gone. He had gained weight. No enlarged nodes were found.

In October 1935 there was again a complaint of diplopia, which had then been present for one month. A consultant reported paresis of the left sixth nerve. In May 1936, the patient was still working but was not free from headache. Lung metastases were diagnosed at this time. On March 7, 1937, physical examination showed a mass at the tip of the sternum that had been present for four months. The left pupil was dilated; both pupils were irregular and reaction to light was gone. The right eye showed slight light perception; acuity of the left eye was diminished. There was paresis of the third nerve on the left. Deafness was almost complete, bilaterally. No cervical mass could be found. Shortly before death, at home, the patient was reported to have passed blood in the urine. Death occurred on Aug. 24, 1937. Duration of life from the onset of the first symptom was three and one-half years.

**CASE 2:** L. D. S., white female, age 17, was seen Oct. 13, 1937, with pain and swelling in the neck. She had noticed a small lump at the angle of the left mandible eleven months prior to admission. The lump has gradually increased in size until now it limited the movement of the mandible. The patient had been treated for sinusitis and tonsillitis.

**Physical Examination:** There was a mass extending from the angle of the mandible to the clavicle, lobulated, and moderately tender. A tumor was found in the nasopharynx at the junction of the soft and hard palate. This extended downward to the level of the epiglottis, pushing the lateral pharyngeal wall to the mid-line and the uvula to the right. In the nasopharynx another tumor was found in the middle meatus on the left. It had the clinical appearance of a sarcoma.

**Pathology:** Biopsy of the nasopharyngeal mass was reported "undifferentiated carcinoma which somewhat resembles a lymphoepithelioma."

**Treatment:** X-ray therapy was given. During the two years that the patient was under observation

7,800 r were given to the left cervical mass and 2,800 r to the left antrum anteriorly; 1,050 mg. hours of radium filtered with 1 mm. of gold were given to the tumor in the nasopharynx.

**Progress Notes:** On Aug. 8, 1938, ten months after the original therapy, a node 1.5 cm. in diameter was still present in the left cervical area. This was removed and was reported non-malignant. In October 1938, the patient complained of severe pain in the left side of the face, double vision, and inability to move her eyes. Antrotomy was done and tumor tissue was removed. It was reported as infected carcinoma, possibly lymphoepithelioma. Death occurred at home, Nov. 23, 1939. Duration of life was three years from the first symptom.

**CASE 3 (Fig. 3):** C. J., Negro female, age 17, was first seen in the outpatient dispensary in 1929, with enlarged cervical nodes. Nine years later she reported in the clinic with a wry neck. She was treated in various departments for wry neck, peritonsillar abscess, and arthritis. She was referred for x-ray therapy in April 1939, because of nodes in each cervical area. A tumor was suspected in the left tonsillar region, but the patient could not open her mouth sufficiently to permit a biopsy. Tonsils removed elsewhere in March 1939 did not show tumor growth.

**Treatment:** A dose of 1,503 r to the left lateral pharynx and cervical area and 1,336 r to the posterior left cervical area was given. The torticollis disappeared and the patient became symptom-free. Treatment was given from April 25 to May 26, 1939.

**Progress Notes:** The patient returned one year later with torticollis and pain, which were relieved by a similar series of treatments. On Feb. 15, 1941, she entered the emergency room with a soft fluctuant mass in the posterior triangle of the left cervical area. A cystic mass was incised and a biopsy specimen was obtained from the margin.

**Pathology:** The biopsy report was "lymphoepithelioma or transitional-cell carcinoma."

**Progress Notes:** Further therapy consisted of 2,500 r to the lateral left cervical area and 2,500 r to the posterior cervical area on the left. X-ray examination revealed mediastinal metastases. A consultant in July 1941 thought there were brain metastases. Death occurred on Oct. 22, 1941.

**Autopsy:** There were metastatic deposits in the cervical, hilar, and mediastinal lymph nodes. The primary tumor was not found.

**"Autopsy note:** Death was probably due to the toxemia associated with an unusually rapidly growing malignant growth, apparently having its origin in the lymphadenoid tissues of the mouth and belonging to the so-called lymphoepitheliomas. The biopsy specimen showed a much more characteristic and typical growth than the various recurrent nodules and metastases noted at autopsy."

The patient lived three and one-half years after her first symptom of torticollis.

CASE 4: E. P., white female, age 60, was admitted Sept. 20, 1940, with swelling about the left eye and nasal discharge. The drainage of the left nostril was blocked and there was loss of vision in the left eye. The first symptoms had appeared about three months prior to admission.

*Physical Examination:* There was swelling of the left side of the face. A cellular tumor was found occluding the left nostril.

*X-Ray Examination:* The left antrum was opaque, with destruction of the antral walls. The picture was that of a malignant tumor in the antrum.

*Pathology:* Tissue removed from the nasopharynx was reported "lymphoepithelioma."

months' duration. He had first noticed a sore throat six months earlier but it had been more severe in the past two months.

*Physical Examination:* There was an ulcerating, proliferating mass 3 cm. in diameter in the left tonsil area. Cervical nodes, rather small and not fixed, were palpable.

*Pathology:* "Lymphoepithelioma of the tonsil" (biopsy).

*Treatment:* Radiation was directed intra-orally to the tonsil, 2,132 r. The cervical nodes were given 3,750 r.

*Progress Notes:* The nodes and the primary lesion rapidly disappeared, and there had been no



Fig. 3. Case 3: Biopsy specimen from cervical node, reported lymphoepithelioma.

*Treatment:* A dose of 2,000 r was applied to the lateral left orbit and antrum; 1,500 r to the anterior left antrum. The tumor rapidly regressed.

*Progress Notes:* Four months later the patient was admitted with proptosis of the left eye and swelling of the left side of the face. Again 1,500 r were given to the anterior and also to the lateral left face. On final admission, March 1941, proptosis of the left eye was marked and brain metastases were suspected by consultants. Death occurred at home on June 2, 1941, one year after the first symptom.

CASE 5: C. M., white male, age 75, was admitted Nov. 25, 1942, complaining of tonsillitis of two

recurrence up to Sept. 1, 1945, over three years since the first symptom.

CASE 6: D. E., white male, aged 17, was admitted March 9, 1943, with a lump in the left side of the neck, present for four months. There were no symptoms referable to the nasopharynx.

*Physical Examination:* There was a large mass of nodes in the left cervical and supraclavicular area. No lesion was demonstrable in the nasopharynx.

*Pathology:* Biopsy of a cervical node was reported "lymphoepithelioma."

*Treatment:* X-ray therapy to the nodes was administered as follows: left lateral cervical nodes,

2,500 r; anterior left cervical nodes, 1,000 r; posterior left cervical nodes, 1,000 r.

*Progress Notes:* There was rapid regression of the mass of nodes. The patient returned on June 22, 1943, with many nodules beneath the skin of the scalp, arms, and abdomen. These varied from 0.5 to 2 cm. in diameter. Death occurred on Aug. 3, 1943, at home. Duration of life was nine months from the first symptom. The primary tumor was never discovered.

CASE 7: G. L., white male, age 60, was admitted Sept. 28, 1943, complaining of a lump in the neck.

*Progress Notes:* This patient was last seen on Sept. 2, 1945, at which time no evidence of tumor was found. He had gained a little weight and was working at hard manual labor. Duration of life is two years and five months from the first symptom.

CASE 8 (Figs. 4 and 5): N. W., white female, age 48, was admitted Oct. 11, 1943, complaining of pain in the back. Our first contact with this patient was when she was referred for cholecystography. It was noted that positioning her on the x-ray table caused a great deal of pain. A film of the dorsal spine showed 50 per cent compression of the 12th dorsal body.

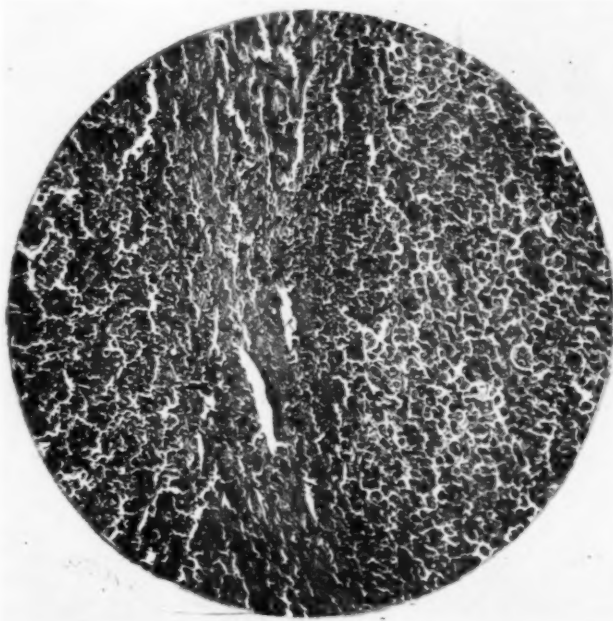


Fig. 4. Case 8: Biopsy specimen from nasopharyngeal tumor, reported lymphoepithelioma (Schmincke type).

This had started to develop in the right cervical area six months prior to admission.

*Physical Examination:* There was a tender fixed mass in the right posterior auricular area and beneath the right ear. The right tonsil was large and ulcerated, measuring 2 cm. in diameter. The cervical mass measured  $8 \times 2.5$  cm.

*Pathology:* Biopsy of the cervical node was reported "lymphoepithelioma."

*Treatment:* From Sept. 28 to Oct. 18, 1943, a dose of 2,847 r was given through a  $10 \times 10$ -cm. portal to the right cervical nodes, while 2,000 r were given intra-orally to the tonsil. In March 1944, since residual tumor was thought to be present in the nodes, they were given an additional 2,486 r.

The appearance was that of pathological compression. On questioning, the following history was obtained. In July a node the size of a walnut had been removed from the right axilla. It had been present for four months. The histologic diagnosis had been "malignant lymphoma." A node in the left axilla had been given x-ray therapy and had disappeared. The patient had been told by her family doctor that gallbladder disease was the cause of the back pain. Our initial assumption was metastasis to the vertebra from a malignant lymphoblastoma.

*Physical Examination:* Small cervical nodes were present bilaterally. The blood count and blood chemistry were normal. X-ray showed metastases with compression of the 12th dorsal vertebra.



Fig. 5. Case 8: Vertebral metastases from lympho-epithelioma of the nasopharynx.

**Treatment:** A dose of 1,700 r to the vertebra and 400 r to each cervical area was given. A brace was secured and the patient returned to her work as a teacher.

**Progress Notes:** On Sept. 19, 1944, the patient consulted a rhinologist because of a small growth in her nares that was causing a little obstruction. She had been conscious of it for four months but since it had not caused any discomfort she had ignored it. Examination revealed a tumor 1 cm. in diameter in the posterior left nasopharynx. It was soft in consistency and not vascular. It was partly removed with an adenotome. Radium in a capsule 1.5 cm. long, filtered with 1 cm. of gold, was applied for a total dose of 1,200 mg. hours.

The next admission was on Dec. 26, 1944, because of a recurrence of pain in the back, referred to the left side. This was severe in the left upper quadrant. Muscle spasm was so pronounced that adequate examination could not be done. The impression was gained that the spleen was about twice as large as normal. The patient refused to stay in the hospital for an adequate amount of therapy to the spine. On Feb. 22, 1945, she returned with fluid in the left pleural cavity, and 1,110 c.c. of blood-tinged fluid

was removed. Fluid was removed on several occasions during the next two months. The last admission was from March 16 to April 10, 1945. Blood chemistry was normal; the white cell count was 5,300 and hemoglobin 68 per cent. Fluid was again removed from the pleural cavity and transfusions were given. The patient realized her condition and asked to be released to return to her home.

**Pathology:** The biopsy report on the nasopharyngeal mass was as follows: "The section shows a number of irregular masses of tissue, some of which are covered on the surface in part by a layer of squamous epithelium, beneath which are extensive areas of lymphoid tissue. There are innumerable pleomorphic cells with a moderate amount of cytoplasm and relatively large pale-staining nuclei, often showing considerable irregular lobulation and commonly containing a prominent eosinophilic nucleolus. The malignant cells commonly exhibit mitotic figures, sometimes quite bizarre in form, and the cells show a diffusely infiltrative type of growth extending irregularly throughout the lymphoid tissue but showing here and there a tendency to form poorly defined clumps and masses, suggesting epithelial origin. They are in some areas, however, intimately intermingled with lymphoid and hyaline collagen bundles. Diagnosis: Lymphoepithelioma (Schmincke type)."

The patient died on May 20, 1945. Duration of life was three years from the first symptom.

**CASE 9 (Fig. 6):** E. O., white male, age 61, was admitted Aug. 16, 1944, complaining of a sore tonsil. Sore throat and a mass of nodes in the left cervical region had appeared simultaneously about two months prior to admission.

**Physical Examination:** There was a large ulcerated left tonsil, forming a mass approximately 3 cm. in diameter. The mass of nodes in the left cervical region measured 5 X 8 cm. and was fixed. Small supraclavicular nodes were also present on the left.

**Pathology:** Biopsy of the primary lesion in the tonsil was reported "lymphoepithelioma, Regaud type."

**Treatment:** Four series of treatments were given in a period of one year. During the first month of treatment a dose of 1,548 r was applied intra-orally to the left tonsil. From Aug. 16, 1944, until Aug. 20, 1945, the total dose was as follows:

Intra-oral to left tonsil.....	1,548 r
Left lateral cervical area.....	9,150 r
Left supraclavicular nodes.....	3,315 r
Submental nodes.....	3,315 r

The intra-oral portal was 3.5 cm. in diameter and the external areas were treated through a portal 10 X 10 cm. A half-value layer of 1.9 mm. copper was secured with a Thoreaus filter.

The primary tumor promptly disappeared, but the nodes were much more resistant. On examination, on Sept. 1, 1945, the skin was found to be in good

condition. An indefinite small node about 1 cm. in diameter was felt high in the cervical area on the left. The patient had no pain at that time and was gaining weight.

CASE 10: J. L., white female, age 70, was admitted Aug. 18, 1944, with a sore throat (left side) of six weeks' duration.

*Physical Examination:* There was an ulcerated, friable mass in the left tonsillar fossa, approximately 3 cm. in diameter. No cervical nodes were felt.

*X-Ray Examination:* No lung metastases were seen.

CASE 11: L. F. S., white female, age 21, was admitted Oct. 16, 1944, complaining of sore, enlarged cervical nodes, left nasal obstruction and drainage, and left facial paralysis. The enlarged nodes were noticed a year earlier. Nasal obstruction became evident at about the same time. Facial paralysis had been present for three months.

*Physical Examination:* There was horizontal nystagmus. The left pupil was dilated and showed a sluggish light reflex. The patient was unable to move the eye laterally, upward motion was poor, and she could not close the lid. There was lymphadenopathy in the cervical chain on each side and in



Fig. 6. Case 9: Biopsy specimen from tonsillar tumor, reported lymphoepithelioma.

*Pathology:* Biopsy of the intra-oral mass was reported "lymphoepithelioma."

*Treatment:* X-ray therapy was given to the intra-oral mass with a 3.5-cm. cone; a dose of 1,548 r was directed to the primary tumor; 3,000 r were given to the left cervical area through a 10 × 10-cm. portal.

*Progress Notes:* The patient was last seen on Sept. 1, 1945. At that time there was no evidence of tumor. A point of interest is the fact that this woman was treated on the same service for a squamous-cell carcinoma of the lip, Broders type II, four years earlier. This has shown no evidence of recurrence or metastasis.

This patient has gone a little over one year without evidence of recurrence of lymphoepithelioma.

the right and left occipital chain. A rather large mass was palpable in the posterior nasopharynx.

*Pathology:* A large portion of the mass in the nasopharynx was removed. The pathological report was "lymphoepithelioma, Regaud type."

*Treatment:* Treatment was given elsewhere.

CASE 12: M. M., white female, age 81, was admitted Nov. 27, 1944, because of inability to breathe through the left nostril. She complained, also, of frequent nosebleeds. The naris had been occluded for about one year.

*Physical Examination:* There was a pale smooth mass occupying the left naris, exerting such a degree of pressure that the nose appeared swollen. Definite nodes were not palpated.

## CASE SUMMARY

Case Number	Age	Sex	Duration from First Symptom	First Symptom	Other Symptoms	Living or Dead
1	16	M	3½ years	Cervical lymph node enlargement	Headache, carache, deafness, diplopia, irregular pupil, metastases to sternum	Dead
2	17	F	3 years	Cervical lymph node enlargement	Double vision, pain in neck, obstruction of nares, mass in nasopharynx	Dead
3	17	F	3½ years	Torticollis	Cervical mass, general metastases	Dead
4	60	F	1 year	Swelling of soft tissue about eye	Occlusion of antrum, proptosis left eye	Dead
5	75	M	3 years	Enlarged tonsil and cervical nodes	None	Living
6	17	M	¾ year	Cervical nodes	Skin metastases	Dead
7	60	M	2½ years	Enlarged tonsil and cervical nodes	None	Living
8	48	F	3 years	Node in axilla	Metastases to vertebrae, lung, and spleen	Dead
9	61	M	1 year	Sore throat	Ulcerated tonsil, large cervical nodes	Living
10	70	F	1 year	Sore throat	Ulcerated tonsil, enlarged cervical nodes	Living
11	21	F	2 years	Cervical nodes; mass in nares	Nystagmus, third nerve paralysis, left pupil dilated	Living
12	81	F	1¼ years	Occluded naris	Nosebleeds	Living

*Pathology:* "Lymphoepithelioma or transitional-cell carcinoma."

*Treatment:* Following removal of a portion of the mass, a capsule of radium containing 50 mg. and having a length of 1.5 cm. was inserted adjacent to the tumor. Filtration was 1 mm. of gold. A total dose of 1,550 mg. hours was applied; roentgen radiation (1,500 r) was delivered to the left face and cervical area.

*Progress Note:* The patient's condition on Sept. 1, 1945, was good. She had then been living one and three-fourths years without recurrence since the original evidence of tumor.

## SUMMARY AND COMMENT

1. Primary malignant neoplasms of the nasopharynx are being recognized more frequently.

2. Lymphoepithelioma is an uncommon tumor arising in this location. It is characterized by a cell type that usually but not always differentiates it from transitional-cell carcinoma. Clinically the site of the primary lesion, the mode of metastasis, and response to irradiation are the same for the two tumors.

3. In our series of 12 cases the average duration of life was two and one-half years for those who are dead. Six of the series are living, their average duration of life being two years. Of the 6 living patients, 5 had a primary tonsillar tumor and one

a primary nasopharyngeal tumor. Five of the series were between the ages of 16 and 21, the other 7 were between 48 and 81; 8 were females and 4 males.

4. Therapy should be started as soon as diagnosis is made and should be intensive. Radium and x-ray therapy deserve equal consideration. The type of radiation used will depend on the facilities available and accessibility of the tumor.

5. Evidence seems to the author to favor a specific tumor called lymphoepithelioma. Whether transitional-cell carcinoma, undifferentiated-cell carcinoma, and lymphoepithelioma are essentially the same has not yet been definitely settled by the pathologist. For therapeutic purposes, the matter is of academic interest. In either case the problem is referred to the radiologist. His success will depend largely upon the stage of the disease and the heroism with which he attacks the problem.

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## Significance of the Sacroiliac Findings in Marie-Strümpell's Spondylitis<sup>1</sup>

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THE CONDITION called Marie-Strümpell's spondylitis in America was first described by Strümpell in 1884. From a study of the clinical symptoms, he concluded that the disease might result from a chronic inflammation of the intervertebral joints. As to the question in which part of the spine the disease begins, he expressed no opinion. Marie, in 1898, was the first to answer that question. Since patients usually gave the lower back as the site of the first symptoms, and since the lumbar spine was often found to be ankylosed while the cervical spine was less affected, Marie concluded that the disease "marches progressively in the ascending direction, from the sacrum to the neck."

X-ray studies have added weight to the theory of Marie. In 1934, the British radiologist Scott expressed the opinion that "changes in the sacroiliac joints always precede the onset of spondylitis." Forestier (France) corroborated the findings of Scott in 1939, and Hare in America joined them in their opinion in 1940. At present the theory that "in spondylitis *adolescens* the sacroiliac joints are first to be attacked by the fixation process" (Blair) appears to be generally accepted. My studies, however, of over 200 cases in the last two decades<sup>2</sup> have given me an opportunity to make some observations which, if corroborated by others, would seem to lead to a conclusion at some variance with the prevailing opinion.

Let us start with an analysis of the sacroiliac findings in patients with Marie Strümpell's disease, since such observations form the basis of all discussions on this subject. The most important thing

to be said of these findings is that they are a manifestation of a process of continuous transformation of the bone structure. They are not uniform, therefore, but vary considerably in the course of the disease. This may account for differences in the studies published on the subject. Two main stages may be distinguished, differing from each other in so many respects that they should be discussed separately.

### STAGE OF PARASACROILIAC OSTEOSCLEROSIS

The earlier stage is characterized roentgenologically by an increased density of the sacroiliac region (Fig. 1). In the beginning, a trabecular arrangement is discernible within the condensed area; later there is a total loss of structural details. The area of condensation is sharply but irregularly delineated. Its size and shape vary to a certain extent in the course of the disease (Figs. 2 and 3). From the very beginning the process of condensation is in the great majority of the cases symmetrical, so that one side looks like a mirror-image of the other.

As to the localization of the process, the condensation extends along the sacroiliac joints. Two points need to be stressed. *First*, the osteosclerotic area is limited to the iliac bones. The impression that the sacrum is affected as well is due to the fact that "the articular portion of the ilium extends behind the anterior edge of the sacroiliac joint, so that the portion of the ilium which lies behind the sacrum may give the appearance of disease of the sacrum" (Hare and Haggart). Actually, the sacrum is involved only in the later stages of the disease, and even then only infrequently.

<sup>1</sup> Read by title at the Thirty-first Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 9-10, 1945.

<sup>2</sup> The cases were seen in the following institutions: General Hospital, Vienna; Rothschild Hospital, Vienna; Clinic of N. Y. University; Hospital for Ruptured and Crippled, New York; Welfare Hospital, N. Y.



Fig. 1. Osteosclerosis along the sacroiliac joints, characteristic of the earlier stages of Marie-Strümpeli's spondylitis.

Fig. 2. Osteosclerosis of the ilium at some distance from the sacroiliac joint.

Fig. 3. Same case as Fig. 2, four years later. The pattern (size and shape) of the osteosclerosis has changed considerably.



Fig. 4. Oblique view of a sacroiliac joint showing that in the stage of osteosclerosis the contours and width of the joint space are normal.

Secondly, the sacroiliac joints are not affected. The impression that the joint is involved is created by the fact that "the sacroiliac joint is oblique; the large auricular surface of the sacrum, facing outwards and backwards, opposes to a similar surface in the ilium, which faces forwards and inwards. Therefore, in the anteroposterior radiograph the lateral borders of the sacrum overlap and the medial borders of the ilia and the joint space cannot be seen" (Brailsford).

The presence of a sclerotic area seemingly surrounding the joint tends to increase the difficulty in evaluating the condition of the sacroiliac joints. Depending on the distribution of the sclerotic area, the joints may appear blurred and narrowed or, in other cases, scalloped and widened on the routine anteroposterior roentgenogram. Anteroposterior films taken from a 45-degree angle, however, or oblique views demonstrate that in the stage of para-

articular osteosclerosis the sacroiliac joints are normal as to their contours and width (Fig. 4).

Thus we see that in this stage of the disease the radiological findings in the sacroiliac region do not indicate the presence of a "sacroiliitis" but merely of an "iliitis." In fact, the radiologic findings are similar to those in "osteitis condensans ilii," as recently stressed by Hare and Haggart. It is only in order to describe the portion of the ilium in which the changes are found that we speak of "sacroiliac" findings and not merely of iliac findings in Marie-Strümpell's spondylitis.

As to the clinical symptoms in this stage of the disease, it is significant that, though many patients complain of pain in the buttocks, in the neighborhood of the sacroiliac joints, pain is not localized in the joints themselves. "It is difficult," wrote Scott, "to explain why pain should be absent from the sacroiliac joint during the most active stage of the infectious process," but "for some unexplained reason pain is not localized in the sacroiliac joints." Similarly there is absence of pain on pressure to the sacroiliac joints. According to Forestier, "it is remarkable that, as a rule, no pain was elicited by pressure at the site of the sacroiliac joints." Both these phenomena, however, are understandable in the light of the fact mentioned above, namely, that we are dealing here not with a process in the sacroiliac joints but in the iliac bones. In "osteitis condensans ilii" there is likewise no pain in the area of condensation, either spontaneously or on pressure.

Since pain is the cause of all the other symptoms in sacroiliac conditions, its absence explains the absence of any other clinical findings referable to sclerosis in the sacroiliac region. A patient suffering from a sacroiliac sprain or sacroiliac tuberculosis, does not sit on the buttock of the affected side because he seeks to avoid the transmission of weight through the joint. When he stands or walks, he is likely to press his hand over the joint to lend it better support (Lewin). None of these signs was

present in my cases of Marie-Strümpell's spondylitis. Other tests used in examinations of the sacroiliac joints, such as the signs of Lasègue, Gaenslein, and Smith-Petersen, were also found to be negative in 42 of my cases with parasacroiliac osteosclerosis. On the other hand, the symptoms of which the patients with parasacroiliac osteosclerosis usually complain are "pains, stiffness in the spine, with muscular contracture, and impairment of the chest expansion" (Forestier). Obviously, none of these can be referred to the findings in the sacroiliac region but point to a lesion of the spinal column at a higher level.

I have not found in the literature any report indicating the presence of pathological findings characteristic of Marie-Strümpell's disease in this early stage. No inflammatory process, no proliferation of the synovial membrane, no pannus destroying the cartilages has been described in the sacroiliac joints, to my knowledge. Scott explored the affected bone from the bacteriological point of view and found it sterile. In a case of "iliitis condensans," which radiologically is closely related to the parasacroiliac osteosclerosis in Marie-Strümpell cases, the affected bone was found on the microscopic examination to be "independent of any inflammatory or other etiology," according to Rendich and Shapiro. Thus the interpretation of the radiological findings in the sacroiliac joints as a manifestation of Marie-Strümpell's spondylitis is not based on pathological studies.

If we compare the early sacroiliac findings with those in the intervertebral joints, we find in the latter, radiologically, "stippled or diffuse rarefaction of articular processes, ranging from slight loss of the density to almost complete dissolution of the bone. The facets of the involved articular processes have indistinct outlines. The intervening joint space is slightly narrowed and sometimes clouded" (Openheimer). Clinically, there is pain on motion and on pressure to these joints, with spasm and stiffness. Pathologically,

an inflammatory edema, proliferation of the synovia, and destruction of the cartilage have been definitely established (Fraenkel, Sivéu, Junghanns, and others).

In every respect, therefore, there is a contrast between the findings in the sacroiliac joints and in the intervertebral joints in the early stage of the disease. In the end we arrive at the somewhat strange conclusion that, according to the prevailing theory, Marie-Strümpell's spondylitis, known to be a radiologically and pathologically well defined, clinically painful disease of the joints, should start with a pathologically obscure, clinically silent affection of the bone.

On the other hand, there is a strong argument in favor of the identity of the pathological process in the sacroiliac joints and in the other joints affected by the disease, in the fact that the stage of parasacroiliac osteosclerosis is followed by an ankylosis of the sacroiliac joints.

#### STAGE OF ANKYLOSIS OF THE SACROILIAC JOINTS

Serial roentgen examinations extended over many years demonstrate that, as Marie-Strümpell's spondylitis advances, a process of decalcification sets in, in the spine as well as in the pelvis, and progresses continuously. While the decalcification goes on, the sclerosis of the bones around the sacroiliac joints gradually diminishes. Since the condensed area contains more calcium than the normal bone, the decalcification is first seen, and for a long period of time is more pronounced, in the bones of the spine and pelvis than in the sclerotic areas. Eventually, however, there is a uniform demineralization around the sacroiliac joints, with a complete loss of structural details. Coincidentally, the joint space displays irregularities of outline and alterations of width. A process of obliteration sets in, which steadily progresses until a complete osseous ankylosis results. The sacrum and ilium form then a single bone with a greatly diminished calcium content (Fig. 5). This can be demonstrated also in oblique views (Fig. 6).



Fig. 5. Same case as Fig. 1, six years later. The sacroiliac joints are now fused, the pelvic bones are decalcified, the spinal ligaments are ossified.

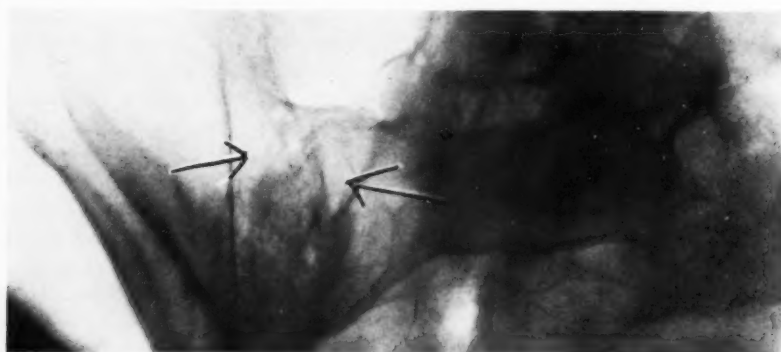


Fig. 6. Same case as Fig. 5. The sacroiliac joint is shown to be fused also in the oblique view, in contrast to Fig. 4.

The osseous ankylosis of a joint is definitely an arthritic process, indicating loss of the articular cartilages and their replacement by a newly formed osseous tissue. The radiological findings adequately picture the pathological state of

the joints. This has its parallel in the final stage of Marie-Strümpell's disease in other joints, as well as in rheumatoid arthritis. There is, however, one fact to be taken into consideration before conclusions are drawn from this parallelism,

namely, that an ankylosis occurs in the sacroiliac joints spontaneously in the course of the aging process. This is in line with the anatomy and physiology peculiar to the sacroiliac joints and foreign to any other joint. Up to about the thirtieth year of life the sacroiliac joint is structurally, as well as functionally, a true diarthrodial joint, lined with a synovial membrane and forming a joint space permitting some motion. This is followed by a stage in which the synovial membrane be-

comes atrophic, the cartilage begins to degenerate, and the joint space is gradually obliterated so that a synchondrosis results, permitting practically no motion. Finally, in old age, when a senile osteoporosis sets in, the cartilages show a tendency to fuse into synostosis (Fig. 7). This tendency of the sacroiliac joints to be gradually transformed from a diarthrosis through a synchondrosis into a synostosis was first established by Barkow, in 1841, and subsequently corroborated by Brooke and Léri. In America, Sashin (1930) and Willis (1933) have published important contributions on the subject, essentially confirming the previous reports. Sashin stated that, "since the entire weight of the body is transmitted through the sacroiliac

joints to the lower limbs as a result of this constant pounding or pressure effect upon the articular surfaces, early degenerative and osteoarthritic changes set in which eventually lead to bone ankylosis." Willis arrived at a similar conclusion: "The sacroiliacs were ankylosed by bone productive changes more frequently than any other joints. . . they were often completely fixed when the other parts of the same skeleton showed little if any similar change."

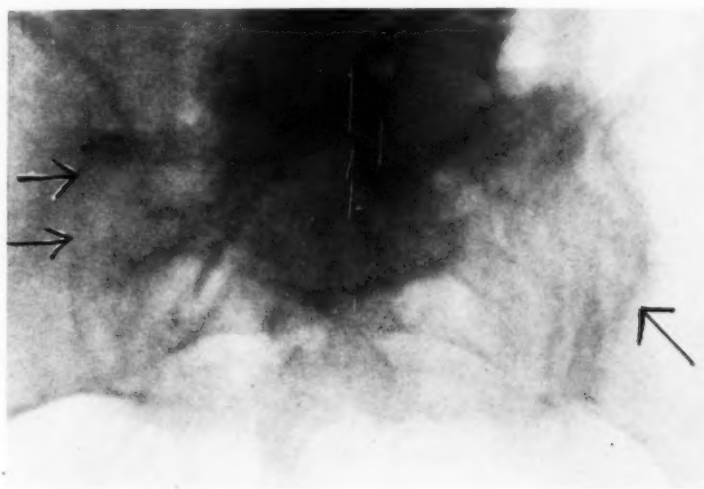


Fig. 7. Senile osteoporosis with fusion of the sacroiliac joints.

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It appears that while an osseous ankylosis in any other joint affected by Marie-Strümpell's disease can be regarded as evidence of a destruction of the articular cartilages by an inflammatory process, this cannot be taken for granted in the sacroiliac joints. Here the fusion may be the result of the ordinary degeneration spontaneously occurring in these joints. There are a few things to suggest that, in fact, the ankylosis in the late stages of Marie-Strümpell's spondylitis may have something to do with the ankylosis observed in the course of the aging process. There is first the fact that no pannus destroying cartilages has been thus far reported in the sacroiliac joints. This may be due to the fact that the synovial membrane of

these joints has a tendency to atrophy and thus is unable to produce the granulomatous tissue (pannus) characteristic of Marie-Strümpell's spondylitis and rheumatoid arthritis, respectively. The fact also is remarkable that, as stressed by both Sashin and Willis, the process of degeneration and fusion of the sacroiliac joints is more frequent, sets in earlier, and progresses more rapidly in males than in females. These findings are of particular

of these joints, namely, that of the synovial membrane to atrophy, that of the articular cartilages to degenerate, and that of the neighboring bones to fuse, are intensified in the presence of Marie-Strümpell's disease. The disease would seem to intensify the efficacy of the factors responsible for the ankylosis of the sacroiliac joints in the course of the aging process and thereby to accelerate the establishment of that condition.

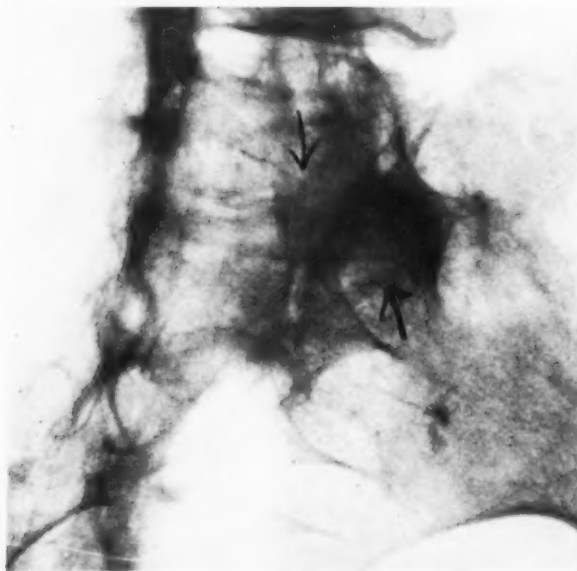


Fig. 8. Lateral view of a sacroiliac joint showing osteosclerosis of both the ilium and sacrum.

interest in view of the fact that Marie-Strümpell's disease occurs predominantly in young males. Finally and most important: the ankylosis of the sacroiliac joints in Marie-Strümpell's spondylitis is associated with a decalcification of the bones just as their ankylosis in old age is associated with senile osteoporosis.

In conclusion, we see that the ankylosis of the sacroiliac joints in the course of Marie-Strümpell's spondylitis is not necessarily the result of the pathological process peculiar to that disease but rather of the physio-anatomical processes peculiar to the sacroiliac joints. The idea suggests itself that the tendencies characteristic

If we now compare the two main stages in the development of the sacroiliac findings in Marie-Strümpell's disease, we see that a process primarily localized in the bone is succeeded by a process in the adjacent joints. Despite their morphologically different appearances, the para-articular osteosclerosis and the osseous ankylosis have two features in common, first their symmetry and secondly the increased content of calcium. Lime salts are deposited in excessive amounts symmetrically, first in the bones near the sacroiliac joints and then, when the bones become decalcified, in the intra-articular spaces of those joints. The two processes seem to be merely two

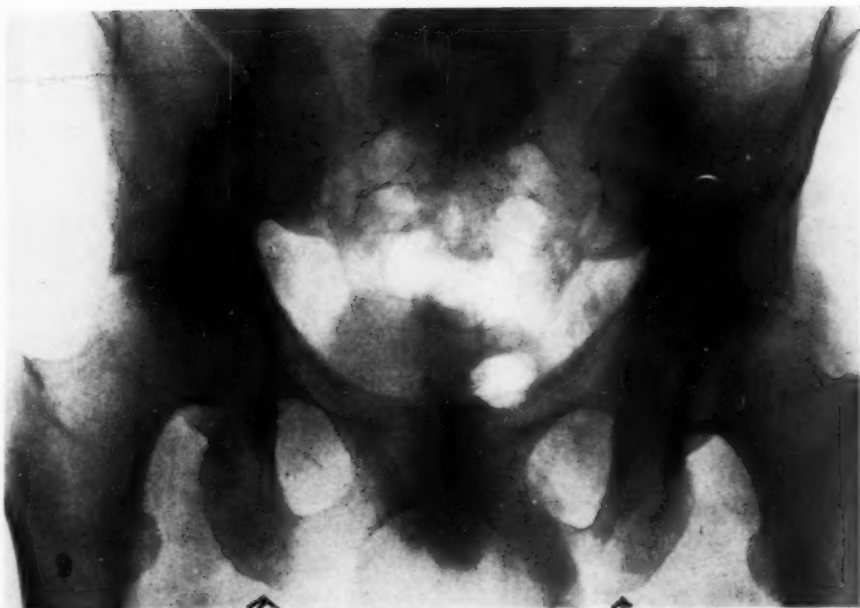


Fig. 9. Advanced case of Marie-Strümpell's spondylitis showing fusion of the sacroiliac joints and osteosclerosis around the sacrolumbar junction.

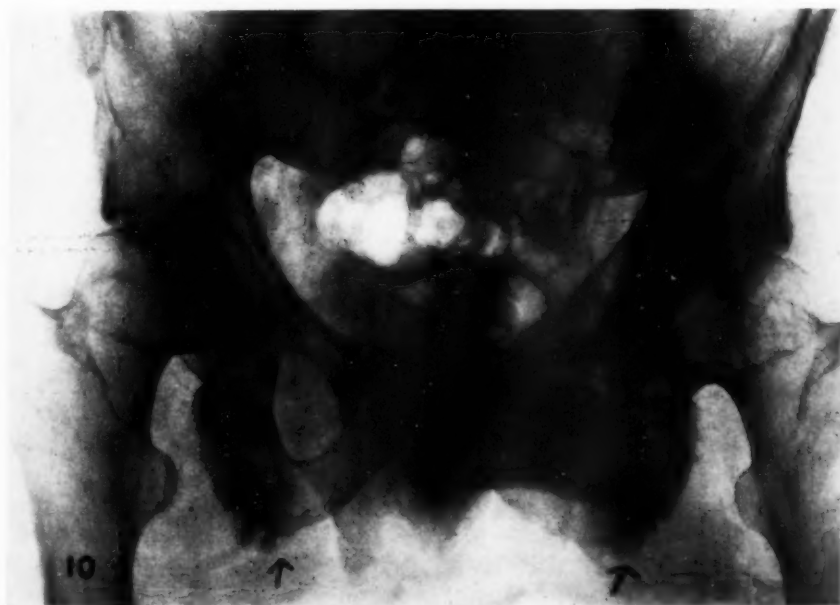


Fig. 10. Same case as Fig. 9, two years later. There is, in addition to the previous findings, a proliferation of the periosteum of the tuberosities of the ischium.

different ways of bringing about the same effect, namely, an increase of the calcium content of the pelvic bones supporting the spine.

#### PELVIC CHANGES OUTSIDE THE SACROILIAC REGION

It has been mentioned that what we see in the sacroiliac region of Marie-Strümpell's spondylitis is a continuous transformation of the bone structure. The process is first limited to the iliac bones. But it does not stop there. As the condi-

tical distribution and an increased calcium content.

#### RELATIONSHIP BETWEEN THE SACROILIAC FINDINGS AND THE LUMBAR SPINE

The theory that Marie-Strümpell's spondylitis begins in the sacroiliac joints and then progresses toward the lumbar spine is based on routine examinations of the spinal column in the anteroposterior and lateral views. Progress, however, has been made in the radiological examination of the spine since it has been studied also in the



Fig. 11. Case of Marie-Strümpell's spondylitis of twenty years' duration. In addition to the fusion of the sacroiliac joints, there was an osteosclerosis of the bones forming the symphysis pubis.

tion advances, some cases show osteosclerotic areas in the sacrum as well (Fig. 8). There is sometimes, also, a condensation of the bones around the sacrolumbar junction (Fig. 9). Later, a new area of osteosclerosis may develop in the region of the symphysis (Fig. 11). Finally, the periosteum of the tuberosities of the ischium, sometimes also that of the ilium, starts to proliferate and, as a result, bony spicules are formed, radiating into the adjacent soft tissues, producing a sunray appearance (Figs. 9 and 10).

The pelvic changes show the same two features which were found to characterize the sacroiliac lesions, namely, a symmet-

oblique direction. Oblique views give us a clear insight into the intervertebral joints, the primary site of Marie-Strümpell's spondylitis. Because of the smallness of the intervertebral joints, alterations are not so conspicuous as in the large sacroiliac joints, and therefore are readily overlooked. Once we are familiar with the normal appearance of the intervertebral joints, however, the diagnostic evaluation of pathological alterations occurring in these joints does not offer more difficulties than, for example, in the phalangeal joints.

In 10 healthy subjects, twenty to thirty-five years of age, films of the lumbar and sacral region were studied in anteropos-



Fig. 12. Narrowing of an intervertebral joint with periarticular sclerosis in an early case of Marie-Strümpell's spondylitis.

terior, lateral, and oblique views, to serve as a standard in the study of pathological cases.

In 32 early cases of Marie-Strümpell's spondylitis in which routine anteroposterior views showed a para-articular osteosclerosis in the sacroiliac region, the lumbar spine was examined in the oblique view also. All, without a single exception, showed definite pathological changes of the intervertebral joints, such as blurring of the contours, narrowing of the joint space, condensation or decalcification of the facets (Fig. 12). These findings have been thoroughly described by Oppenheimer in his important contribution on the subject. Surprisingly enough, the first definite signs of the disease are very frequently found in the upper lumbar spine and lower dorsal spine, between D11 and L2 (Fig. 13), much farther from the sacroiliac region than they are commonly expected. This, too, may be a factor explaining why the changes often are overlooked.

Forty-one late cases, showing an ankylosis of the sacroiliac joints, revealed the presence of advanced changes in the spinal column, such as ankylosis of the intervertebral joints, extensive calcification of the spinal ligaments, and definite osteoporosis of the vertebrae and pelvis.

Thus we found that, whenever the sacroiliac region was involved, the lumbar spine was affected as well. This has a counterpart in the observation of Oppenheimer that in a number of cases "the sacroiliac joints were normal both on clinical and



Fig. 13. Calcification of parts of the spinal ligaments between D11 and D12. The corresponding intervertebral joints are ankylosed.

roentgenological examination; in these cases the apophyseal joint lesion was confined to the thoracic or cervical vertebrae." In other words, in the absence of changes in the lumbar spine, changes in the sacroiliac region also are absent. On the other hand, we found in our series no instance of pathological findings in the lumbar spine without changes in the sacroiliac region, although in some cases the latter were so slight that they escaped many observers. The absence of cases with negative sacroiliac findings in the presence of changes in the lumbar spine in our series is perhaps due to the fact that the initial symptoms of Marie-Strümpell's spondylitis are so vague and insidious that many patients do not see a physician in the early stage of the disease. In some of our cases the disease was not suspected by the physician who first saw the patient and roentgenograms of the spine were not taken. In other cases the lumbar and dorsal spine showed roentgen changes characteristic of beginning Marie-Strümpell's spondylitis but the sacroiliac region was not examined because no symptoms referable to that area were present. Scott, however, despite his

assertion that the "changes in the sacroiliac region always precede the onset of spondylitis," admitted that "a small percentage of cases showed no sacroiliitis on the first examination but some time later." Scott worked in a hospital specializing in the treatment of rheumatic diseases, in which x-ray films of the sacroiliac region were routinely taken in all younger persons complaining of backache. Early cases with negative findings in the sacroiliac region could be detected under these circumstances. Such cases are, necessarily, as

#### THE SACROILIAC FINDINGS AND X-RAY THERAPY

The effectiveness of x-ray therapy in Marie-Strümpell's spondylitis, especially in the pre-ankylositic stages, becomes more and more common knowledge (Scott; Hare; Oppenheimer; Smyth, Freyberg, and Lampe; Baker; Rees and Murphy, and others). Treatment of "ankylosing spondylarthritis" with x-ray is mentioned by Professor G. Holzknecht of Vienna in his book "Dosage Tables for X-Ray Therapy," 1922.<sup>3</sup> Being for many years in



Fig. 14. Unilateral osteosclerosis of the ilium in a case of Marie-Strümpell's spondylitis.

rare as those showing the initial stages of any other chronic condition.

It is less unusual to see cases in which, in the presence of well defined findings in the lumbar spine, only one sacroiliac joint is affected on the first examination (Fig. 14). Later in the course of the disease the other sacroiliac becomes affected as well (Fig. 15). Here it is evident that the changes in the lumbar spine preceded at least those in one of the sacroiliac joints. Such cases are suggestive of the presumable development of the sacroiliac findings in relationship to those in the lumbar spine at the very onset of the disease.

charge of x-ray therapy in Holzknecht's clinic, I had the opportunity of treating cases of Marie-Strümpell's spondylitis as early as twenty years ago. At that time the diagnosis was considered certain only when the spine showed marked ossification of the ligaments. Usually, therefore, only advanced cases were treated. Nevertheless, the pain-alleviating effect was impressive and highly appreciated by both patients and attending physicians. This changed, however, when, following the

<sup>3</sup> An English translation of these tables is included by I. Seth Hirsch in his book "Principles and Practice of Roentgen Therapy" (1925).

theory that the disease starts in the sacroiliac joints, I began to irradiate that region.

If the ineffectiveness of the x-ray treatment of the sacroiliac joints escaped Scott, this is to be attributed to his so-called "wide-field" technic. With this method, treatments are given from a long distance so that the entire trunk is exposed to the rays. Consequently, both the sacroiliac joints and the spine are irradiated, so that the ineffectiveness of the irradiation of the sacroiliac region is not apparent.

Forestier used radioactive injections intramuscularly or intravenously, so that here, too, the entire body was exposed to the action of the rays, and the ineffectiveness of the treatment of the sacroiliac joints again escaped attention.

Hare directed the rays "to the entire spine, the sacroiliac joints, and the paravertebral and gluteal muscles." He used 6 portals, on 6 successive days. Under these circumstances he had no chance to ascertain whether the favorable result of the therapy was due to the treatment of the sacroiliac joints or the other areas.

The ineffectiveness of irradiation of the sacroiliac joints for pain localized in their neighborhood becomes, however, unequivocal if we treat one region at a time and the next region only when the result of the previous treatment is ascertained. Applying the same dose to all regions treated, we find that irradiation of the sacroiliac joints is never successful. By contrast, the pain localized in their neighborhood subsides if the lumbar spine is irradiated. This suggests that the pain around the sacroiliac joints does not originate in the joints but is merely referred from the lumbar region.

The ineffectiveness of irradiation of the sacroiliac joints manifests itself in still another way. If the sacroiliac joints are in the stage of para-articular osteosclerosis and are irradiated directly, the development of an ankylosis of these joints cannot be prevented. If, however, in this stage x-rays are directed not to the sacroiliac joints but to the lumbar spine, and if these treatments are successful in decreasing



Fig. 15. Same case as Fig. 14, two years later. The osteosclerosis is now bilateral.

pain and increasing motility, ankylosis of the sacroiliac joint fails to develop. This impressive course of events suggests that the development of the sacroiliac findings is not invariable but is controlled by influences originating in the lumbar spine. The practical conclusion following from these observations is that, in treating Marie-Strümpell's spondylitis with x-rays, irradiation to the sacroiliac joints should be omitted. It is a waste of time and expenditure; it may discourage the patients and the attending physicians from the further use of x-ray therapy; in females it is harmful to the ovaries, without any compensating benefit.

#### SUMMARY AND CONCLUSIONS

1. The osteosclerosis in the sacroiliac region seen in the early stages of Marie-Strümpell's spondylitis is confined to the iliac bones, leaving the sacroiliac joints free. The findings demonstrate a pathological process of the bone but not a disease of the joint.

2. The ankylosis of the sacroiliac joints seen in the late stages of Marie-Strümpell's spondylitis has not been proved to result from a destruction of the cartilages by a pannus, as is the case in other joints affected by the disease. On the other

hand, it has its analogy in a process peculiar to the sacroiliac joints leading to their ankylosis in the course of the aging process.

3. The sacroiliac findings do not give rise either to pain or any other clinical symptoms. The symptoms encountered in patients with sacroiliac findings point to the lumbar spine as the site of origin.

4. X-ray therapy given to the sacroiliac region is ineffective. It does not alleviate any symptoms nor does it prevent ankylosis. By contrast, the symptoms around the sacroiliac joints subside and ankylosis is prevented when the lumbar spine is irradiated.

In view of these facts, the following conclusions may be tentatively drawn.

The inflammatory process taking place in the spinal joints affected by Marie-Strümpell's spondylitis causes pain, spasm, and stiffness. A chronically progressive restriction of mobility results. Such a restriction of the mobility of one part of a body naturally has some adverse effects on the parts with which it is anatomically connected. In the case of the lumbar spine, the longer it is immobilized, the more it becomes functionally integrated into the pelvis. As a result, a bigger block of bones is formed, requiring a stronger support. This induces a chain of physiological reactions tending to restore the weight-bearing capacity of the sacroiliac junctions, which are severely taxed by the disorder. As the final result of these processes, larger amounts of calcium are deposited in the regions affected, so that the increased stress resting on these pillars is counterbalanced. The symmetry of the sacroiliac findings seen in the great majority of cases, even in the earliest stages, points in that direction. The os ilii, being the largest pelvic bone, is first involved and contributes to this end more than the others. The calcium is first deposited along the joints in the direction of "the lines of force," a well known method of adaptation of the bone to an increased stress (Skinner). Later, a uniformly dense sclerosis results. Presumably, when the condensation of the

iliac bones proves insufficient to increase the weight-bearing capacity of the pelvis, there is sometimes also a condensation of parts of the sacrum and of the bones around the lumbosacral junction. Later, a new area of condensation develops in the region of the symphysis as symmetrical as in the sacroiliac region.

When in the course of the disease, due to the progressing immobilization, a decalcification of the bones sets in, new bone is formed outside the normal skeleton. The osseous ankylosis of the sacroiliac joints illustrates this way of satisfying the demands for a better support. The bone is formed and deposited in the articular spaces of the sacroiliac joints, as is the case in the ankylosis of these joints occurring in the course of senile osteoporosis. Another instance is the proliferation of the periosteum of the tuberosities of the ischium, giving rise to the formation of bony spicules radiating into the soft tissues.

The assumed type of relationship between the sacroiliac and lumbar findings may account for the fact that, while in cases with sacroiliac findings pathological changes invariably were present, no sacroiliac changes were found in cases in which the lesion was confined to the thoracic or cervical vertebrae. In cases of unilateral involvement of the sacroiliac region it may be assumed that the osteosclerotic reaction of one iliac bone was sufficient to offset the disturbed balance temporarily. Eventually, the other iliac bone had to react, also, to restore the weight-bearing capacity of the sacroiliac joints.

In the light of this hypothesis, the sacroiliac findings are not produced by Marie-Strümpell's spondylitis but merely reflect the occurrence of a pathological process immobilizing the lumbar spine. In other words, they do not represent a lesion but a reaction. The diagnostic value of the sacroiliac reaction becomes clear when it is compared to another reaction which has proved of value in the diagnosis of Marie-Strümpell's spondylitis, namely, the sedimentation test. The increased sedimentation of the red blood cells indicates the

presence of an inflammatory process in the body, while the increased calcium content in the sacroiliac region indicates the presence of an immobilizing process in the neighborhood of the joints. The increased sedimentation rate can be likened to the increased temperature, the sacroiliac reaction to the "*defense musculaire*" in appendicitis. Though not a mirror, as an indicator of certain pathological processes in the lumbar spine, the sacroiliac reaction is a very important aid in the diagnosis of Marie-Strümpell's spondylitis. The diagnosis, however, can be regarded as definitely established only when, in addition to the sacroiliac findings, pathological changes are also demonstrated in the intervertebral joints, the primary site of the disease.

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# Solitary Cyst of the Calcaneus<sup>1</sup>

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**S**OLITARY BONE cyst of the calcaneus is a rare lesion. Sobel (8) and B  cl  re (1) each presented a proved case in 1936. Smith (7), in 1930, reported a case which was not operated upon. This he believed was "either osteitis fibrosa, or, rather, a mere architectural peculiarity," and not to be considered as a true bone cyst. Fitte and Mulcahy (4) presented four unproved cases in 1939. Caritat (3) reviewed the literature to 1941 and added a proved case. Brailsford (2), in Fig. 77 of the second edition of his book, "Radiology of the Bones and Joints," illustrates a typical cyst, which he calls an area of osteoporosis.

We have encountered three cysts of the calcaneus within a short time. Two of the patients have been operated upon. The third case is so characteristic that it has also been included in this study.

**CASE I:** A 22-year-old white male was admitted with pain in the left heel. He had noticed the onset of this pain on or about May 8, 1944, and it had gradually become worse, so that walking produced distress. There was no swelling, discoloration or pain on motion of the foot. There was, however, tenderness to palpation. A roentgenogram (Fig. 1) showed a rounded cyst-like area, measuring 2.5 cm. in diameter, in the lateral aspect of the calcaneus at the junction of the anterior and posterior halves. All other roentgenographic and laboratory findings were within normal limits.

On June 5, 1944, the lesion in the calcaneus was exposed and entered. A unilocular cavity without trabeculations was found. A slightly turbid yellowish fluid was released when the cavity was opened. The lining of the cavity was curetted. Several small bone fragments were sent to the laboratory for study. The fascia, muscles, and skin were sutured. A dry dressing and a plaster boot were applied. Healing was uneventful. The report of a roentgenographic examination made at another hospital on Oct. 9, 1944, stated that the cystic area had almost completely filled in.

Grossly, the specimen consisted of numerous small fragments of cortical and spongy bone. The cortical bone appeared in the form of thin gray plates. The

cancellous bone was fairly soft and easily crushed by the fingers.

Microscopically (Fig. 2), the most noteworthy finding was the presence of a large cyst lined by closely packed fibroblasts. In some areas the fibroblasts were flattened, while in others they were swollen and tended to be round. This inner layer of condensed cells was continuous with a looser type of connective tissue consisting of abundant collagenous fibrils and sparsely scattered spindle-shaped and stellate fibroblasts. Secondary small cysts, similar to the large one described, were formed in this area. The fibrous tissue was richly supplied with dilated, thin-walled blood vessels. Fresh hemorrhages were encountered in this loose fibrous tissue while, in denser areas, nests of large histiocytes laden with hemosiderin pigment were found. Here and there, singly or in small groups, were multinucleate giant cells in the vicinity of the cysts. The fibroblasts showed transition forms to osteoblasts, which lined numerous irregular trabeculae. These consisted of osteoid tissue, areas of irregular calcification of the matrix, and areas of solid bone. The trabeculae were continuous with cortical bone, which varied greatly in thickness. In the thicker portions of the cortex, the cement lines and the calcification were irregular. Along some trabeculae and parts of the inner surface of the cortex numerous osteoclasts were found. Frequently the trabeculae and the cortex formed a bony encasement of the cyst and were separated from its lumen only by a few layers of fibroblasts.

**CASE II:** A 23-year-old white male was admitted on July 28, 1944, with a history of pain in the ankle and heel of four months' duration. The pain was dull and aching in character at the beginning but had become gradually worse until the patient was no longer able to bear weight comfortably.

A roentgenogram (Fig. 1) showed an apparently multilocular cystic lesion, measuring about 3 × 6 cm., in the anterior half of the lateral aspect of the calcaneus. All other roentgenographic and laboratory findings were normal.

On Aug. 14, 1944, this region of the calcaneus was exposed through an incision below the lateral malleolus, and the cavity was opened after separating the fascia, muscles, and periosteum. A yellow serous fluid was expelled as the cyst was opened. The cavity was unilocular and partly compartmented

<sup>1</sup> From the Roentgenologic and Laboratory Services, and the Orthopedic Section, Lovell General Hospital, Fort Devens, Mass. Accepted for publication in September 1945.

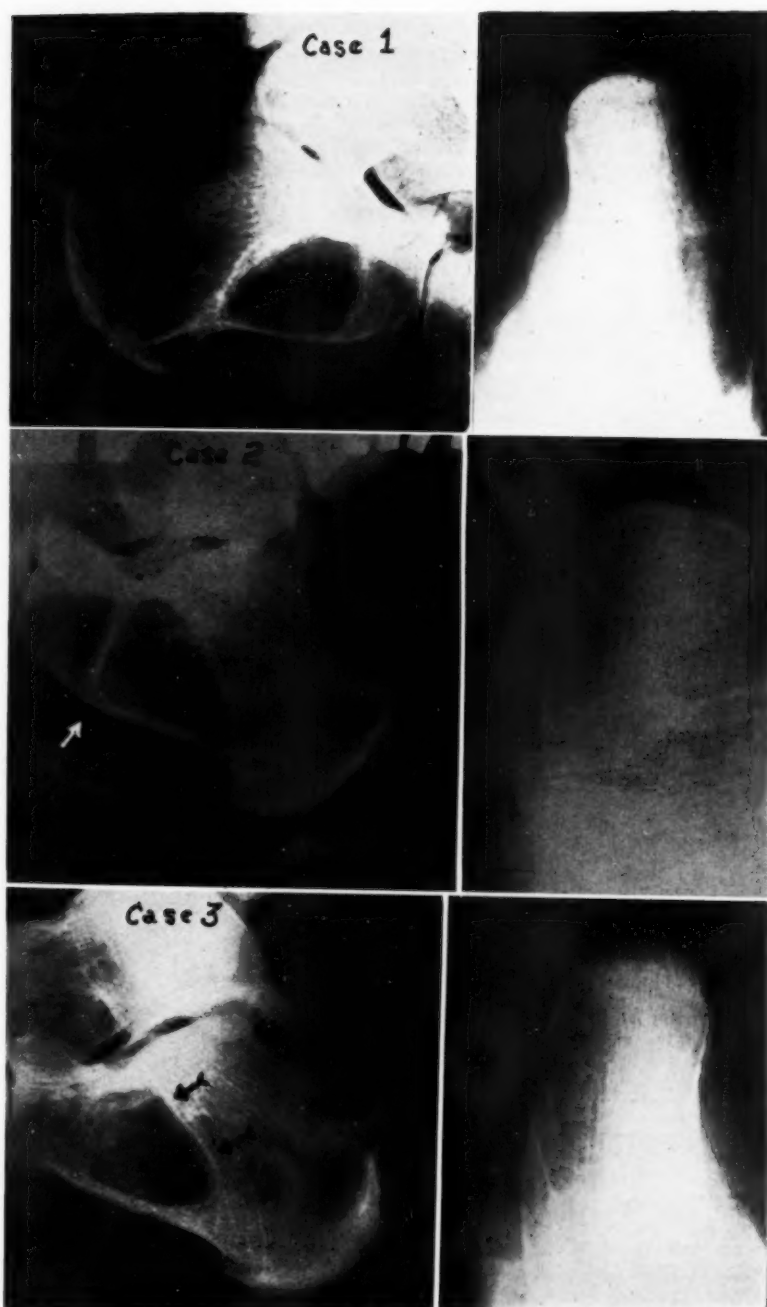


Fig. 1. Each cyst appears to start from the oblique trabeculae which delimit the anterior from the posterior half of the bone (black arrows in Case 3). Note the slight expansion of the cyst walls in Cases 1 and 2 (white arrow). The low incomplete septa in Case 2 give the appearance of multilocularity.

by incomplete septa, which appeared as low ridges. These were rongeured away and the lining was curetted. The muscle fibers were then coapted with No. 40 cotton, and the skin with silk sutures. A dry dressing and a plaster boot were applied. Healing was uneventful.

Grossly, the specimen consisted of about two dozen fragments of spongy bone, mixed with thin plates of gray cortical bone, aggregating a bulk 2.0 cm. in diameter.

were found (Fig. 3). Occasionally, bone trabeculae were separated from the lumen of the cyst only by a narrow zone of condensed fibrous tissue.

CASE III: A 26-year-old white male was admitted to the hospital one week after his induction into the Army. He gave a history of the onset of a fungus infection of his right foot about one month before. An ulcer was present at the plantar aspect of the base of the 4th toe and another on the dorsum



Fig. 2. Case I. Cyst cavity (a) lined by dense fibrous tissue (b) and partly encased by bone trabeculae (c).

The fragments consisted of cortical and spongy bone and of a mixture of dense fibrous connective tissue, osteoid tissue, and bone trabeculae. On the surface of some fragments could be seen a layer of collagenous fibrous tissue of varying thickness which delimited a large cyst. Frequently, the fibrous tissue was more cellular and appeared condensed near the surface. Here and there the nuclei tended to assume a palisade arrangement. In the deeper layers bands of osteoid tissue and bone trabeculae

of the foot. A roentgenogram (Fig. 1) revealed a cystic lesion in the calcaneus, measuring about 2.5 cm. in diameter. All other roentgenographic and laboratory findings were normal. Because of the presence of infection and the absence of complaints referable to the cyst of the calcaneus, no operation was performed.

The following table briefly summarizes the cases seen and reviewed by us.

Author	Age	Sex	Operation
Sobel	15	M	+
Béclère	Not stated		+
Smith	53	M	-
Fitte and Mulcahy	14	M	-
	28	F	-
	32	M	-
Caritat Copleman, Vidoli, and Crimmings	26	F	+
	22	M	+
	23	M	+
	26	M	+
	26	M	-

cyst. The duration of the symptoms is usually short.

#### ROENTGENOGRAPHIC DIAGNOSIS

Characteristically, there is a large, sharply margined translucent area in the anterior half of the calcaneus (Fig. 1). The cyst is situated in the lateral portion



Fig. 3. Case II. Cyst wall showing tendency to palisading of nuclei (a). Bands of osteoid tissue are seen at the lower left (b).

Most of the patients have been young adult males. The age range is from 14 to 53. Almost all of the patients complained of pain on walking. The cyst was an incidental finding in our third case. The physical examination in these patients is not revealing except for varying degrees of tenderness on palpation over the site of the

of the bone, abutting upon, and sometimes expanding, the inferior and lateral cortex. In almost all of the cases, the cyst has been large enough to reach and extend along the subastragalar cortex, but no expansion has occurred at this site. Unlike the solitary cysts of the long bones, the calcaneal lesions take the form of truncated pyra-

mids, the posterior margin lying parallel with the long trabeculae of the posterior half of the bone. This margin appears to fall in almost exactly the same place in every case. The differences in size and shape of the cysts seem to depend on the extent of enlargement from this base in an anterior direction.

Occasionally, the cyst appears to be multilocular (Fig. 1, Case 2), but at operation the trabeculation has been found to be due to ridges or low septa. This finding has been described by Jaffe and Lichtenstein in cases of solitary cyst in the long bones.

In the case reported by Caritat (3), three small fragments of dense bone were found loose in the cyst cavity.

All of the cases show roentgenographic features which are so much alike that, once recognized, they seem to make operative proof unnecessary for the acceptance of the diagnosis.

#### PATHOGENESIS AND PATHOLOGY

Mikulicz' contention that solitary bone cyst is a disease entity has received the support of Jaffe and Lichtenstein (5). He believed that its predilection for young subjects and for regions of active growth in the long bones suggested that it represents some local disturbance of bone growth and development. He believed further that it represents a local post-traumatic dystrophy. The theory that the calcaneal lesions may be solely due to the stress of walking or running is attractive, but against this are the rarity and unilaterality of the lesions.

It is striking that all of the cases seen or reviewed by us have occurred in the same location in the bone. In view of the frequent occurrence of simple fractures at the junction of the anterior and posterior halves of the bone, it is probable that this region may be one of greatest stress. It is difficult to escape the impression that mechanical factors may be responsible for the formation of these cysts.

Lenormant (6) found that the calcaneus is a spongy bone reinforced by three kinds

of trabeculae. The posterior trabeculae extend downwards and backwards, the anterior group extend in the reverse direction, and the third group is a combination of the other two (Fig. 4). There are many variations in the prominence of the third, mixed group. It may be that one of the large intertrabecular spaces may expand to form a cyst under proper stimulation. As far as can be determined, the development of the calcaneus is no more rapid in this region than in any other.

The gross and microscopic features of these cysts are exactly the same as those observed in the solitary cysts of the long bones described by Jaffe and Lichtenstein. The microscopic features which characterize these lesions are typically those described for the tissue obtained from our Case I. For greater detail, the paper of Jaffe and Lichtenstein should be consulted. These authors state that such lesions should not be regarded as a healing phase of a giant-cell tumor, or as related to fibrous dysplasia or osteitis fibrosa cystica, since there is no histologic proof to warrant such suppositions. Occasionally, in one part of a microscopic section it is impossible to differentiate between osteitis fibrosa cystica and a simple bone cyst. Examination of multiple sections, however, should leave no doubt as to the identity of the lesion.

#### TREATMENT

As with cysts in the long bones, surgical entry and curettage will produce healing. Bone chips may be inserted at the time of operation, but this is not necessary for a cure.

#### DISCUSSION

A solitary unicameral cyst of the calcaneus does not appear to differ from a similar lesion in any other bone in either the gross or microscopic features. It is a rare lesion which occurs in the same place in every case seen or reviewed by us, namely, the infero-lateral aspect of the anterior half of the bone.

The cyst consists of a single chamber, which may show ridges of more or less

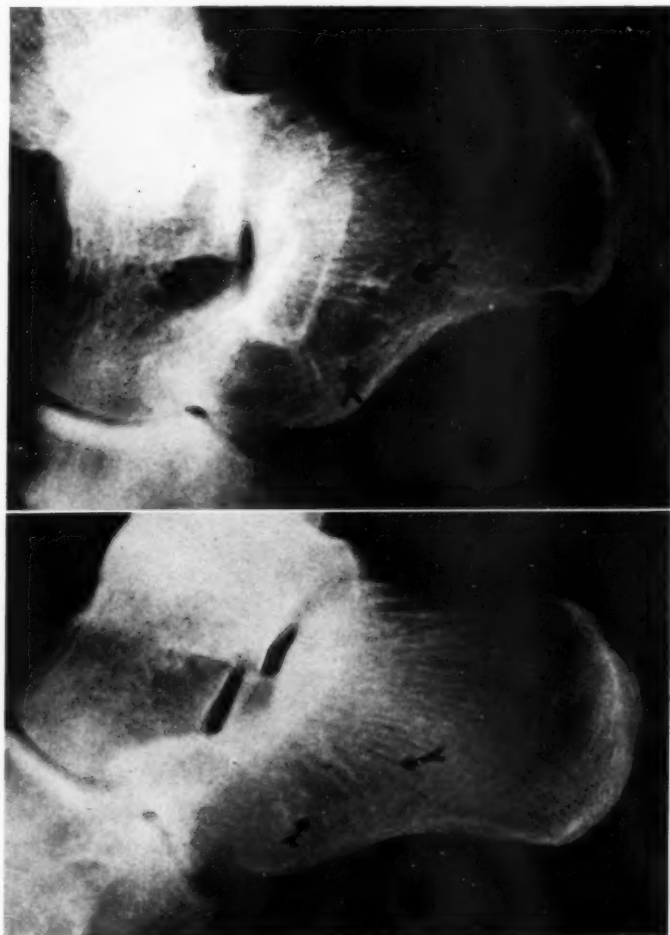


Fig. 4. Two normal bones show the slight irregularity of the middle group of mixed trabeculae (arrows) which may be implicated in the development of a cyst.

prominence on its inner wall. The presence of these ridges tends to create the roentgenologic appearance of multilocularity. The cysts appear to start at the junction of the anterior and posterior halves of the bone and extend anteriorly. In each of our three cases the cyst was located beneath the lateral cortex. The cysts are filled with a yellowish or serosanguineous fluid. In one of the cases in the literature the cyst contained three small sequestra.

The appearance of all of the published cases is identical in almost all details except size. By means of the tangential view

we have been able to demonstrate the lateral position of the cysts.

#### SUMMARY

1. Nine cases of solitary cyst of the calcaneus have been reported or illustrated in the literature. Of these, three have been operated upon. We have added three cases, two of which have come to operation.

2. The cyst is unicameral and is always seen in the anterior half of the body of the calcaneus. In our cases, and probably also in the others, the lesion has been situated in the lateral aspect of the bone. All of the

cysts seem to start at the junction of the anterior and posterior halves of the calcaneus and extend anteriorly as they grow.

3. The patients are most commonly young adult males. Pain on walking or standing and local tenderness are usually the only symptoms.

4. The cyst may originate as a localized dysplasia resulting from multiple small traumata.

5. Cure may be expected after curettage.

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## Pulmonary Torulosis<sup>1</sup>

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ACCORDING TO Strong (10), the genus *Torula* consists of an "ill-defined group of yeast-like fungi with pathogenic properties. . . in which the organisms reproduce only by budding, do not produce mycelium or endospores, and do not ferment carbohydrates. They rarely if ever cause lesions of the skin, but appear to have definite affinities for the tissues of the central nervous system and the lungs, though they may produce destructive granulomatous lesions in other organs of the body. The respiratory tract is regarded as the probable portal of entry.

"Freeman (1931) collected a number of cases of central nervous system involvement, which suggested neoplasm or encephalitis, but were associated with the presence of yeast-like organisms, *Torula histolytica*.

"Dodge has called this organism *Cryptococcus histolyticus*."

### REVIEW OF LITERATURE

Levin (6), in 1937, reviewed 60 cases of *Torula histolytica* infection of the central nervous system. In 9 of these cases, lung involvement was also reported; 8 of the 60 cases were of generalized torulosis; in one of these the lung was apparently not involved. Thirty-seven of the 60 cases were diagnosed antemortem, but in no instance was the diagnosis made from the lung lesion.

Binford (1), in 1940, supplemented Levin's collected series with a summary of 14 additional cases reported in the literature, in 5 of which either the organism or a *Torula* granuloma was found within the thoracic cage.

Reeves, Butt, and Hammack (8), in 1941, added 6 more cases, bringing the total number collected to 80. In one of their patients, seen because of symptoms referable to the central nervous system, a

large *Torula* granuloma was found in the lung and the diagnosis was made from purulent fluid aspirated from the chest. Treatment was with potassium iodide, sulfapyridine, and undenatured *Torula* antigen No. 1 (Krueger); in April 1940, two and one-half years after the onset of symptoms, the patient was still living, though organisms were obtainable from the spinal fluid. During this time there had been noteworthy regression of the pulmonary lesion.

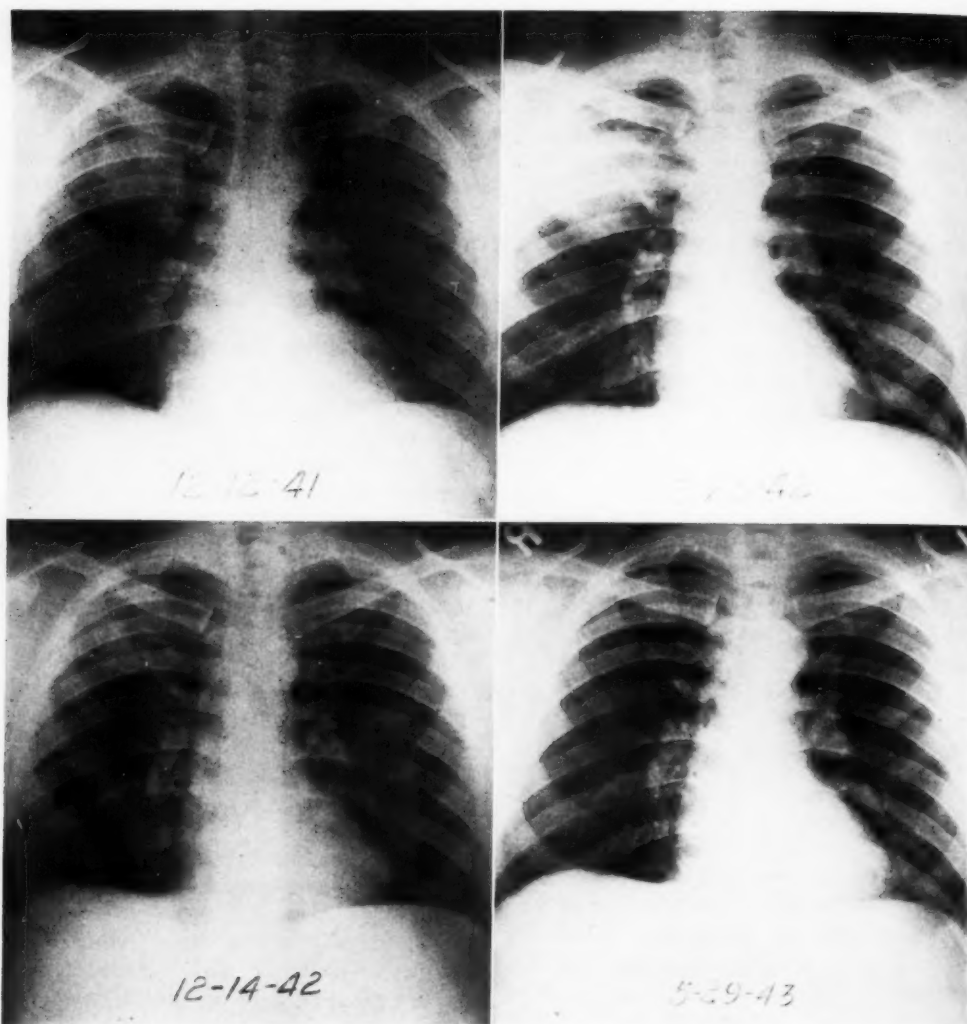
In 1943 Burger and Morton (2) again reviewed the literature, collecting about 100 cases, to which they added 4 cases of their own. They did not report the incidence of lung involvement in the isolated cases published (and reviewed by them) since Reeves, Butt, and Hammack's article (8). One of their own patients was found to have "chronic bronchitis and bronchiectasis; confluent lobular pneumonia with bronchogenic abscesses, right lower lobe." Otherwise, no evidence of lung involvement was demonstrated in their 4 cases.

Lung involvement alone is rare, having been reported in one case by Sheppe (9) (though the central nervous system was not examined postmortem) and in one case by Hardaway and Crawford (4), in which during fifteen months' observation no central nervous system symptoms developed, though a roentgenogram of the chest showed persistent parenchymal involvement.

Patients with *Torula histolytica* infection, either generalized or of the central nervous system, not uncommonly have pulmonary involvement. One such case, with reproductions of roentgenograms of the chest, is reported by Reeves, Butt, and Hammack (8). The diagnosis in this case, even though the central nervous system was involved, was made from the chest lesion as mentioned above.

Changes in the lungs demonstrable on

<sup>1</sup> Accepted for publication in July 1945.



Figs. 1-4: Case of Swanson and Smith.

Fig. 1. 12-12-41. The patient was entirely asymptomatic and the finding was incidental, being discovered on examination for the Army. Note the triangular opacity on the right extending from the hilar zone to the periphery in the upper lobe.

Fig. 2. 3-23-42. The patient was still asymptomatic. Note the increase in the size of the area involved.

Fig. 3. 12-14-42. The patient was still asymptomatic. Note the decrease in size of the parenchymal lesion following therapy.

Fig. 4. 5-29-43. Shortly after onset of cerebellar symptoms (but after treatment) the chest lesion had almost completely disappeared.

roentgenograms, while inflammatory in appearance, are not characteristic. Magruder (7) reports pulmonary roentgen findings in one of the 3 cases he has reported, consisting in cotton-like areas of infiltration at the bases and an increase in fibrosis at the right base.

This article is written to add one more case of *Torula* infection involving both the central nervous system and lungs and to call attention to the possibility of diagnosis from chest lesions.

Swanson and Smith (11) in the second case which they reported did not include

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reproductions of roentgenograms of the chest. Since one of us was a consultant in that case and it has a direct bearing on the diagnosis in the case to be presented, we believe that a brief summary, with reproductions of selected roentgenograms, is worth while.

#### CASE REPORTS

SWANSON AND SMITH'S CASE II: On Dec. 12, 1941, a robust white male, age 36, who appeared to be in excellent health, was rejected for service in the Army because of a triangular opacity in the right lung (Fig. 1) with its apex in the hilum and its base extending to the periphery from the level of the first to the third ribs anteriorly. About four months later (Fig. 2), *Torula histolytica* was cultured from the sputum and gastric contents at Duke University Hospital. Following massive doses of potassium iodide, chemotherapy, and the administration of an autogenous vaccine, the size of the pulmonary lesion diminished (Fig. 3). Regression continued and on May 29, 1943, the infiltration measured only about 2 cm. in diameter (Fig. 4). At that time spinal fluid was reported normal in all respects.

In June 1942, pain in the neck and headaches developed. These recurred intermittently until March 1943, when they became more severe and signs of a cerebellar tumor became evident. At that time the spinal fluid pressure was 350 mm. Examination of the fluid showed a cell count of only 6 cells per cubic millimeter; the protein measured 184 mg. per cent, sugar 89 mg. per cent; cultures were negative for *Torula*. At operation, a large granuloma was found in the right cerebellar tonsil. The following August the patient died.

**Autopsy:** There was a tumor projecting from the right cerebellar hemisphere. The following findings were reported by Swanson and Smith (11): "Serial sections of the brain revealed no other gross lesion and no evidences of meningitis other than mild thickening of the arachnoid over the base of the brain.

"Examination of the viscera showed no significant lesions except in the lungs and spleen. Cysts similar to those of the brain were present in the upper lobe of the right lung; small cysts were seen in the spleen on microscopic examination."

**Comment:** A diagnosis of *Torula* infection was made from studies of the sputum prior to the onset of symptoms referable to the central nervous system. Although the pulmonary lesion regressed after treatment, central nervous system symptoms developed and progressed. Freeman and Weidman (3), as reported by Burger and Morton (2), divided the disease

into three types, the third of which is described as "an embolic form, with deeply placed lesions lying chiefly in the gray matter," which is believed to account for the absence of positive findings in the spinal fluid.

**AUTHORS' CASE:** A white female, age 24, member of the WAC, had a final type physical examination for military service on Nov. 25, 1942, in Los Angeles, Calif. The report on a chest roentgenogram at that time was: "No pathology noted." Following basic training in Des Moines, Iowa, and in Kansas City, Mo., she was assigned to duty in Florida in May 1943.

She enjoyed good health until July 12, 1943, when pleuritic pain occurred in the left lower chest, posteriorly. This symptom persisted, and nine days later, on hospitalization at a station hospital, a roentgenogram (Fig. 5) revealed a rounded opacity in the upper portion of the left lower lobe. This had the characteristics of an inflammatory lesion. The only positive clinical findings at that time were mild fever of 99.6° and suggestive bronchial breathing over the involved area. The chest pain rapidly subsided and on July 27, 1943, the patient was discharged to duty. She was followed as an outpatient but remained asymptomatic.

On Sept. 11, 1943, a progress chest roentgenogram revealed an increase in the size of the lung lesion and the patient was readmitted to the hospital for bronchoscopic examination. This revealed no unusual findings, but a mild, non-productive, persistent cough developed. Except for a white cell count of 10,200 with a normal differential, laboratory studies, including sputum examinations for acid-fast organisms, were negative. Further study was deemed indicated and on Sept. 24, 1943, the patient was transferred to an Army General Hospital with the diagnosis of "unresolved atypical pneumonia."

Physical examination at this hospital was negative except for slight increase in breath sounds over the left lower chest, posteriorly. Laboratory studies, including blood cultures, sputum examination for acid-fast organisms and fungi, serum protein, blood NPN, and sugar determinations, a glucose tolerance test, cholesterol determination, and a basal metabolism test, all gave normal findings. The Kahn test was negative. On Sept. 25, 1943, the blood count was as follows: red cells 4,800,000, hemoglobin 96 per cent, white cells 15,000 with a normal differential count. The sedimentation rate was 8 mm. total in one hour. On Oct. 6, 1943, the white blood count had dropped to 8,600, with a normal differential count, and the sedimentation rate was still normal at 2 mm. total in one hour. A chest roentgenogram on Sept. 27 showed that the lung lesion now apparently contained multiple excavations (Fig. 6). The forty-eight-hour reading of a tuberculin patch test (Lederle) on Oct. 30 was negative.

The temperature, pulse, and respirations continued normal and, except for the mild cough, the patient remained asymptomatic until Nov. 2, when, six days after administration of saturated solution of potassium iodide was begun (5 drops three times daily after meals), chills and fever developed. The drug was discontinued, but for a period of eight days the temperature fluctuated between 99° and 104°. During this period the white blood count increased to 13,400, with 80 per cent neutrophils, 12 per cent lymphocytes, and 8 per cent monocytes, and the sedimentation rate increased to 51 mm. total per hour. Following this episode, the white blood count and differential count remained within normal limits and by Nov. 25 the sedimentation rate had decreased to 17 mm. total per hour.

Chest examinations on Nov. 8 and 9 revealed clicking râles at the end of inspiration over the left lower chest, posteriorly. Bronchoscopic examination was performed on Nov. 8, and the following report was made: "Inspection of the tracheobronchial tree on the left revealed no evidence of ulceration, fixation, or tumor mass formation. A mild degree of acute inflammatory reaction was noted around the orifice of the left upper and lower lobe bronchi. An aspirating tube was passed into the second divisions of both the upper and lower lobe bronchi and these divisions were found to be patent. There could be demonstrated no direct or indirect evidence of bronchial obstruction on this examination." Following bronchoscopy, the patient appeared to improve; her cough practically disappeared, and the temperature remained essentially normal. On Jan. 10, 1944, she complained of mild headache, but examinations, including retinoscopy, were normal, and on Jan. 20 she was discharged to limited duty, for observation.

Six days later the patient was readmitted to her station hospital, complaining of severe headache, vomiting, and generalized aching. Spinal punctures on Jan. 29 and 31, 1944, revealed an increased pressure of 360 and 380 mm. of spinal fluid, which grossly appeared clear. Microscopic examinations were reported as showing a marked increase in white cells, mainly lymphocytes. Spinal fluid protein was 30 mg. and sugar 57 mg. Symptoms rapidly increased, including severe headache, vomiting, blurred vision, and diplopia. Examination revealed bilateral papilledema and a diminished right biceps reflex. On Feb. 8, the patient was transferred back to the Army General Hospital in a semicomatose condition, with the diagnosis of "lung malignancy with metastases to the brain."

Shortly after readmission to the General Hospital, on the basis of the clinical course and roentgen findings, a presumptive diagnosis of *Torula histolytica* infection involving the pulmonary and central nervous systems was made. On Feb. 9, 1944, a ventriculogram showed no abnormalities in the outline of the ventricles. Although the spinal fluid was under increased pressure, it showed no gross ab-

normalities when removed from the ventricles. A spinal puncture on Feb. 12 registered greatly increased pressure, 600 mm.; the fluid was clear and contained 180 cells per cubic millimeter, 160 of which were interpreted as lymphocytes. Spinal fluid cultures, however, revealed a budding yeast organism, typical of *Torula histolytica*. The fluid showed 47 mg. of sugar, 91.4 mg. of protein per 100 c.c. A test for globulin was positive; the Wassermann reaction was negative but the colloidal gold curve was 4443321000. Other laboratory studies, including blood counts and urinalyses, were normal.

Physical findings at this time were few—paralysis of the right internal rectus, markedly diminished corneal reflexes, suggestive Babinski signs bilaterally, and mild hypersensitivity of the entire right side. The patient remained semicomatose, complaining of headache and occasionally vomiting.

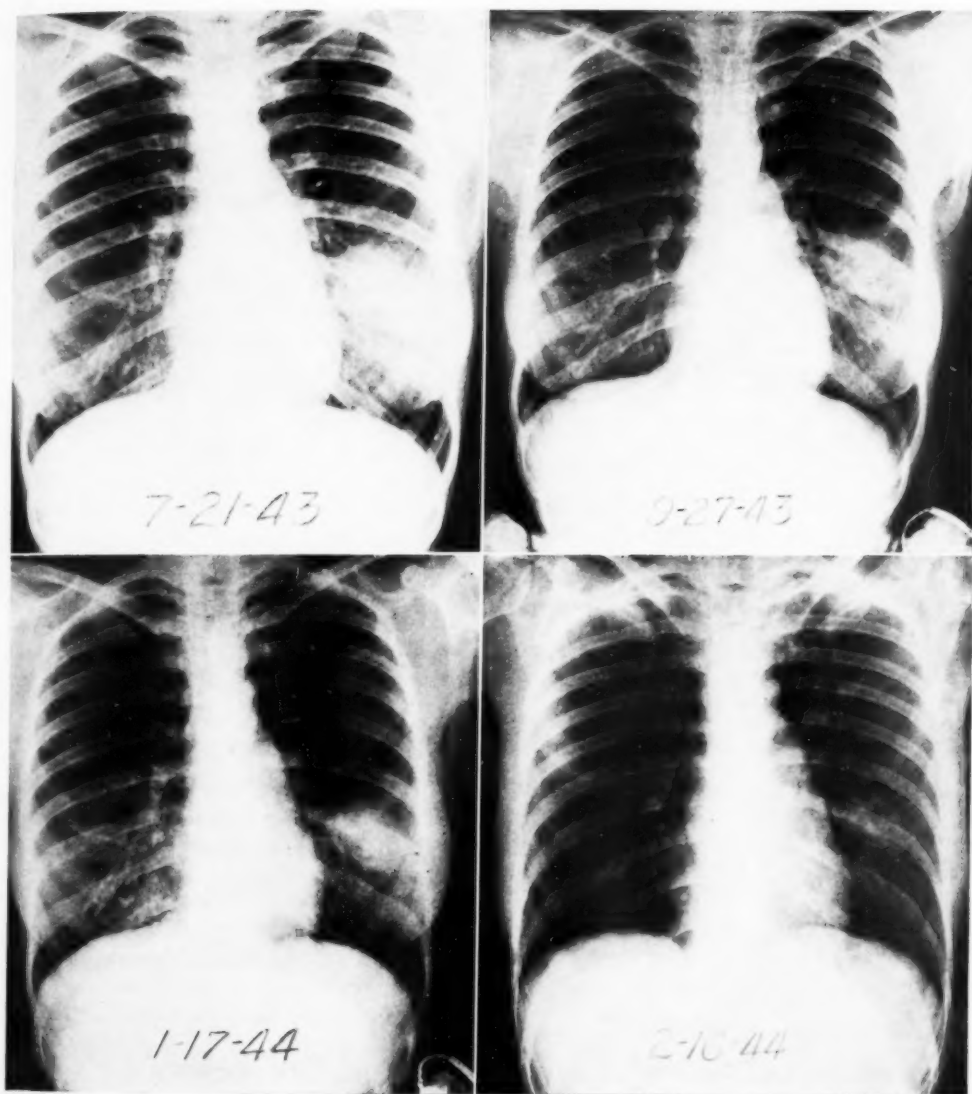
Saturated solution of potassium iodide, 3 minims three times daily, was given, and the dosage was eventually increased to 15 minims three times daily. Eight days after admission, one week after institution of potassium iodide therapy, a chest roentgenogram (Feb. 16) showed partial clearing of the lung lesion (Fig. 8). No clinical improvement occurred, however, and sulfathiazole was given, followed by penicillin therapy. A total of 110,000 units was given—10,000 units intrathecally in divided doses of 5,000 units each and 100,000 units intramuscularly, 10,000 units being given every three hours.

Bacteriological assays demonstrated that the organism grew vigorously in cultures containing all of the available sulfa drugs and even more vigorously in penicillin cultures; subcultures grew without difficulty in dilutions from 1:100,000 to 1:10,000 acriflavine. All medication except potassium iodide was therefore discontinued.

Nine days after admission the patient suffered a severe convulsion, followed by increased difficulty in swallowing and generalized muscular twitching. The spinal fluid pressure progressively diminished, and punctures were discontinued on the twelfth day after admission. Laboratory studies at this time revealed an 85 per cent hemoglobin and 4,110,000 red blood cells. There was a leukocytosis of 13,800, with 88 per cent polymorphonuclear neutrophils. The sedimentation rate showed an increase, 55 mm. fall per hour, and the clinical course was progressively and steadily downhill. The neurological findings increased, pulse was rapid, respirations became Cheyne-Stokes in character, and death ensued on Feb. 27, 1944, the nineteenth day after the patient's second admission and seven months after the onset of symptoms. Just prior to death, the pulse was recorded as 160 beats per minute and the temperature was found to be 107°.

**Autopsy:** Gross findings at autopsy included a pleurisy adjacent to the upper portion of the left lower lung. In the upper portion of the left lower lobe was a hemorrhagic circular lesion, approximately 5 cm. in diameter, which on section showed

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Figs. 5-8. Authors' Case.

Fig. 5. 7-21-43. Nine days after onset of pleurisy the round opacity, having the characteristics of an inflammatory lesion, in the upper portion of the left lower lobe was demonstrated. The patient rapidly became asymptomatic but the finding persisted.

Fig. 6. 9-27-43. Although the patient continued asymptomatic, the lesion persisted and the film shows areas interpreted as excavations. Bronchoscopy failed to reveal evidence of obstruction.

Fig. 7. 1-17-44. There were still no symptoms, but the lesion persisted unchanged in character. *Note:* The increased markings in the lower lobes are due to residual lipiodol following bronchography, which merely outlined the mass in the parenchyma.

Fig. 8. 2-16-44. Following iodide therapy the regression of the lung lesion is demonstrated. Central nervous system symptoms, which had developed, progressed, apparently unaffected by any form of treatment.

irregular cavitation, was loculated and filled with a reddish-brown gelatinous necrotic material. The lesion was not sharply demarcated from the lung, and in the surrounding lung tissue there were irregular foci of gray consolidations resembling bronchopneumonia. Smears and cultures of the necrotic material revealed *Torula histolytica*.

The exterior of the brain grossly appeared normal except for evidence of the recent ventriculogram in the occipital region but, after fixation in formalin, many minute cysts were found in the mid-brain, especially on the left side, and there were two sharply circumscribed, firm, semitranslucent areas in each occipital lobe, measuring 8 mm. in diameter.

Microscopic examination of the lung revealed innumerable organisms typical of *Torula* in the central portion of the hemorrhagic region described above. There was considerable necrosis in this area, but the inflammatory response was not striking, although there were increased vascularity and lymphocytic infiltration. The adjacent lung tissue showed characteristic areas of bronchopneumonia, the alveoli containing fibrin and leukocytes.

Sections of the areas in the occipital lobe showed circumscribed regions of complete loss of brain substance with only strands of supporting stroma remaining. Scattered through these areas were innumerable round and oval budding forms typical of *Torula*. As in the lung, the inflammatory reaction was very slight, there being only perivascular cuffs of lymphocytes adjacent to the above-described areas. Sections of the mid-brain showed similar changes. The meninges likewise showed only a slight inflammatory reaction, containing lymphocytes and a few plasma cells with rare multinucleated giant cells. The organisms were also seen scattered throughout the meninges and occasionally were found to have a very pale-staining irregular deposit of capsular material.

Nothing remarkable was found in the other organs.

The final pathological diagnosis was pulmonary torulosis with metastasis to the central nervous system.

#### DISCUSSION

With the earlier case in mind, after the onset of symptoms referable to the central nervous system, a presumptive diagnosis of *Torula histolytica* infection was made prior to laboratory confirmation. The basis for this diagnosis was the presence of a lesion in the lung parenchyma with inflammatory characteristics, which for half a year changed little in appearance and was for the most part asymptomatic, had resisted diagnosis by laboratory tests, and was followed by symptoms referable to the

central nervous system. The course of the disease had not been suggestive of a malignant growth. It is noteworthy that the lesion in the chest receded following iodide therapy but that the central nervous system involvement resisted all forms of treatment. It is also worthy of note that the organisms were resistant not only to sulfathiazole but to 110,000 units of penicillin. The organisms flourished *in vitro* in a culture plate in the presence of penicillin and in dilutions of acriflavine. Harford *et al.* (5) have also called attention to the lack of beneficial effects of penicillin in the treatment of *Torula* infection.

The identification of *Torula histolytica* can readily be overlooked by laboratory technicians unfamiliar with the organism. It is important to have the slides reviewed by a pathologist acquainted with this form of yeast-like fungus when the infection is suspected.

In retrospect, it seems not unlikely that the reported increase in lymphocytes in the spinal fluid represented *Torula* organisms and not a real increase in lymphocytes.

#### SUMMARY

Torulosis not infrequently manifests itself by producing pulmonary lesions, which in turn often antedate demonstrable involvement of the central nervous system. These pulmonary lesions are usually asymptomatic or nearly so and may be found either on routine roentgenologic examination of the chest or, as in our case, mild symptoms may call attention to the pulmonary infection. In these cases roentgen findings far exceed those expected from the standpoint of symptomatology. The changes occurring in the lungs, as reported by others, may assume various appearances and are not characteristic of the disease, but usually suggest the possibility of tuberculosis. The lung lesion may precede by many months the onset of symptoms referable to the central nervous system and tend to regress when massive doses of potassium iodide are administered. The possibility of pul-

monary torulosis should be borne in mind when there is a persistent asymptomatic or relatively asymptomatic parenchymal lesion which has inflammatory characteristics and which is resistant to diagnosis by ordinary laboratory procedures, especially if the patient is showing no evidence of a malignant neoplasm. Our experience suggests that neither penicillin, sulfathiazole, nor acriflavine has any value in the treatment of this condition.

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# Congenital Cystic Disease of the Lung<sup>1</sup>

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THE CHARACTERISTIC features of congenital cystic disease of the lung are sufficiently known today so that the diagnosis may be surmised from the clinical history, the physical findings, and especially the roentgenographic picture. The multifarious aspects of the malady may, however, be a source of misinterpretation to the roentgenologist not familiar with them.

Congenital cystic disease of the lung is defined as consisting in intrapulmonary heterotopic spaces (or a single space) whose walls are composed of bronchial lining epithelium and whose fluid content is a product of the bronchial epithelium. The cysts may be single or multiple, with or without communication with a bronchus.

Congenital cystic disease of the lung presents itself in two forms: cystic disease proper and the "fluid cyst." The former is characterized by numerous cystic cavities, which may involve a part of a lobe, a whole lobe, an entire lung, or both lungs. The cysts communicate freely with their respective bronchial branches. Examination of a large series of cases would reveal various stages of transition, from the normal to frankly multiple cystic involvement. Many names have been applied to this form of the disease, as congenital bronchiectasis, honeycomb lung, etc. The following case is illustrative of this type:

**CASE I (Figs. 1-3).** *Preoperative Diagnosis:* Bronchiectasis of right middle lobe. *Postoperative and Pathological Diagnosis:* Congenital cystic disease of right middle lobe.

S. D., a 39-year-old female, entered the hospital on Dec. 13, 1943, complaining of pain in the right side of the chest, which had appeared for the first time in 1936. The past history revealed the usual childhood diseases and a right-sided pleurisy in February 1943. The pain was said to be periodic

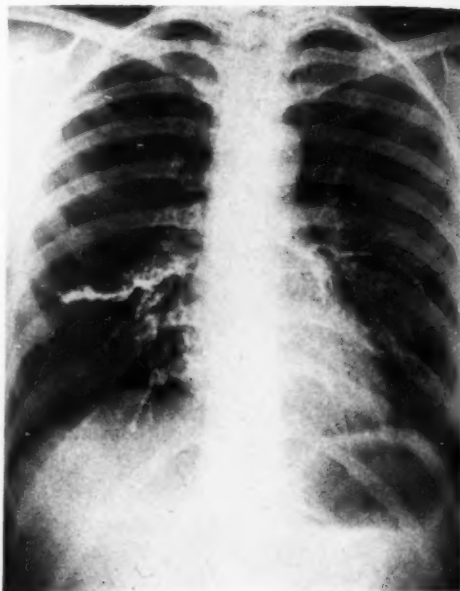


Fig. 1. Case I: Iodized oil outlining the dilated bronchus in the right middle lobe and the cystic cavities.

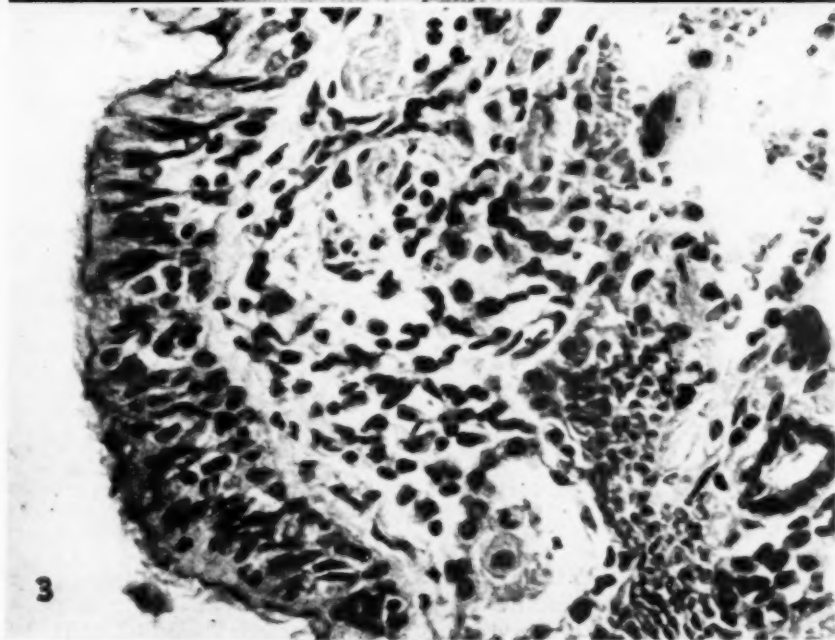
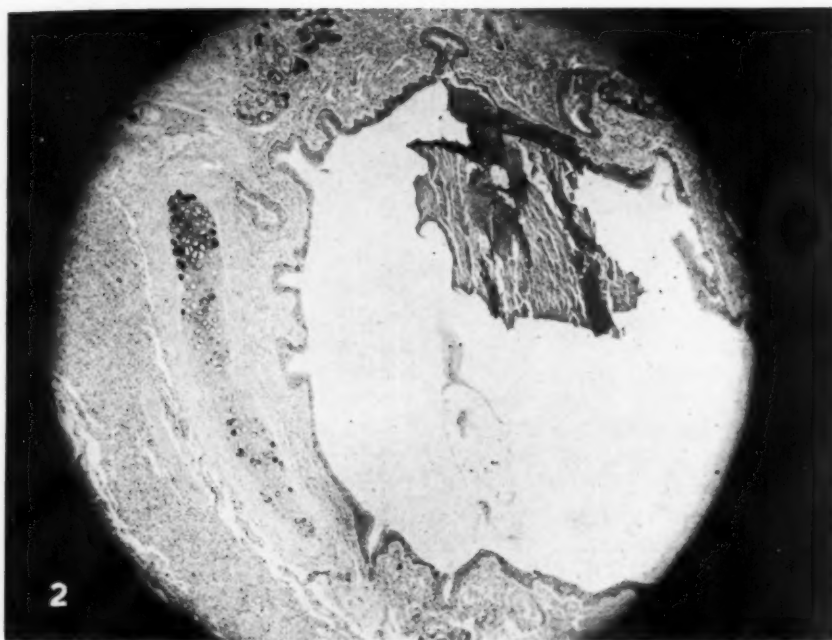
and of constrictive nature, accompanied by a hacking and moderately productive cough. There had been an episode of hemoptysis in 1936.

The blood pressure was 90 mm. Hg systolic and 60 diastolic; hemoglobin 12.5 gm. Examination of the sputum was negative for tubercle bacilli.

Routine fluoroscopic examination of the chest disclosed no evidence of a parenchymatous lesion. The heart and aorta presented no abnormalities; the trachea was in the mid-line. Roentgen studies with iodized oil (Fig. 1) showed a saccular dilatation of one of the larger bronchi in the right middle lobe, with definite cupping at the bronchial end. The cystic cavities were fairly well outlined.

Lobectomy of the right middle lobe was performed on Dec. 21, 1943, by Dr. William Adams and Dr. J. E. Bryant. The pleural surface of the specimen was smooth. The parenchyma was crepitant. The cut surface showed four cavities, varying from 0.5 to 1.0 cm. in diameter. The lining epithelium was an even yellowish-gray. No fluid was seen. Microscopic sections showed large cystic cavities lined with

<sup>1</sup> From the Departments of Surgery and Radiology, Provident Hospital, Chicago. Accepted for publication in August 1945.



Figs. 2 and 3. Case I. Fig. 2 shows one of the large cystic cavities. Note the coagulated protein within the lumen of the cyst. Fig. 3 shows the pseudostratified epithelial lining of the cystic cavity.

high columnar pseudostratified to low cuboidal epithelium (Figs. 2 and 3). The underlying connective tissue and smooth muscle bundles formed large septa between the cysts.

*Comment:* The case described above corresponds to one of the two forms of congenital bronchiectasis described by Grawitz (1), in which one of the main bronchi constitutes a large cyst, all its collateral branches being dilated and debouching into it. The second variety, much more common, is the telangiectatic bronchiectasis in which the bronchioles are more or less uniformly dilated, giving the typical appearance of the so-called honeycomb lung.

The mechanism that brings about the congenital dilatation of the bronchi is still in the domain of hypothesis. Some believe that atelectasis and a faulty embryologic arrest of the alveolar tissue play a role in the genesis of the condition. Others incriminate congenital syphilis as the underlying factor. Grawitz, and later Parmelee and Apfelbach (2), observed a collection of fluid in the fetal bronchioles. This, they believed, would cause bronchial dilatation. Stoerk (3) and others regard the lesion as neoplastic, since they observed proliferation of epithelial and connective tissue, giving a picture similar to that of fetal adenoma.

There are no characteristic pathologic findings. The close resemblance to fetal lung indicates the origin of these cysts; that is to say, they are the result of faulty embryologic development. The occasional demonstration of associated congenital abnormalities, as bronchial adenoma or abnormal bronchi, the evidence of cystic changes in the lungs of premature infants, favor the congenital theory.

The cysts may be quiescent for years, and the bearer may reach adult life without being aware of the condition. Various underlying processes betray its presence, especially infection from distant foci, chronic sinusitis, and other upper respiratory infection. Rarely a sudden attack of hemoptysis will open the scene. In the vast majority of cases, however, the symptoms are pain and productive cough.

If the cysts are infected, differentiation from acquired bronchiectasis becomes difficult. In the case under discussion, the nature of the bronchial secretion, which was mucoid and odorless instead of being frankly purulent and foul, over a period of seven years, and the location of the pathologic process in the right middle lobe, without involvement of the lower lobe, should have led to a correct diagnosis.

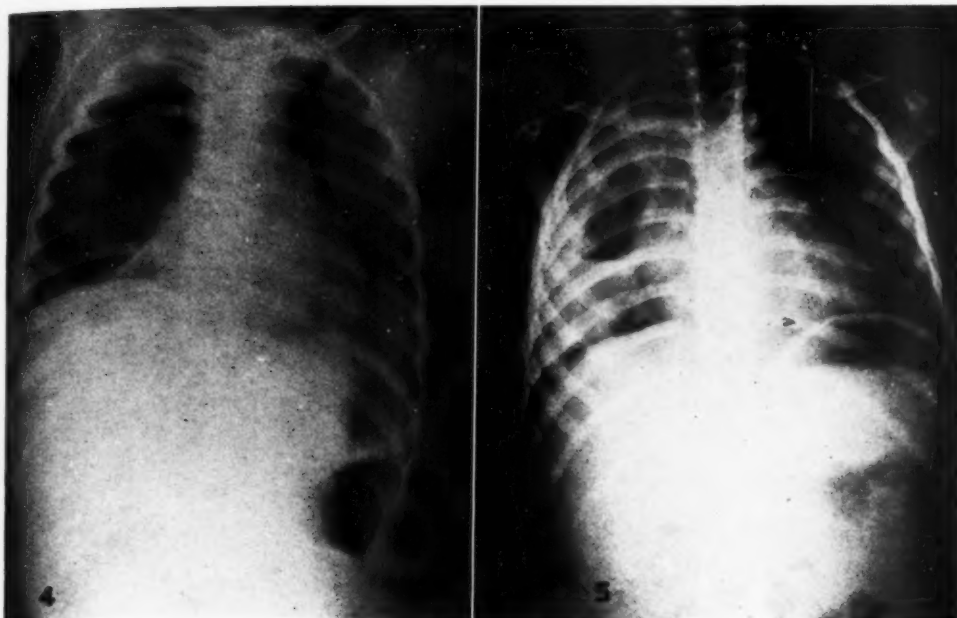
The "fluid cyst" is primarily asymptomatic and appears roentgenographically as a localized area of increased density, with smooth contour. Infection through its wall by microorganisms and the cough reflex, bringing into play the diaphragm and other respiratory muscles, may sweep away the cystic contents, wholly or partially, into the bronchial tree, or, rarely, may cause the cyst to rupture into the pleural cavity, producing a hydropneumothorax or pyothorax.

The following case has been reported elsewhere (4). Here it is considered from a different point of view and roentgenograms not previously published are reproduced. It illustrates the possibility of rupture of the fluid cyst into the bronchial tree, with discharge of its contents, and their replacement by air, giving rise to a pneumocyst.

CASE II (Figs. 4 and 5). I. S., aged 3 years, entered the hospital Jan. 7, 1935, with symptoms of pleurisy with effusion. The temperature on admission was 103°. The child was born at term and had a normal developmental history except for repeated "colds." On numerous occasions she had expectorated copious amounts of yellow material.

Physical examination showed a well developed child, with slight dyspnea of decubitus. Percussion of the chest revealed dullness over the base of the right side and increased resonance in the right upper third. Mantoux tests were negative.

X-ray examination disclosed a multilocular air sac with almost complete absence of normal lung in the right side of the chest. A band of pulmonary tissue at the right base formed septa and gave to the cyst a multilocular appearance. The pleura could be well outlined from the thoracic wall, and the linear shadows observed throughout the cystic cavity were curved, rather than straight as in cases of pneumothorax. A diagnosis of large solitary multilocular cyst was made. There was no displacement of the heart, and the mediastinal structures were in their



Figs. 4 and 5. Case II. Fig. 4 shows the large cyst replacing the entire right lung. The heart and mediastinal structures are not displaced, indicating that the intrathoracic pressure is not greater than the atmospheric pressure. A later film (Fig. 5) shows reduction in the size of the cyst. The bands of lung tissue forming septa are clearly seen, giving to this solitary cyst a multilocular appearance.

normal position (Fig. 4). Subsequent roentgenograms demonstrated a significant decrease in the size of the air cyst (Fig. 5). Retained secretion was observed on two occasions.

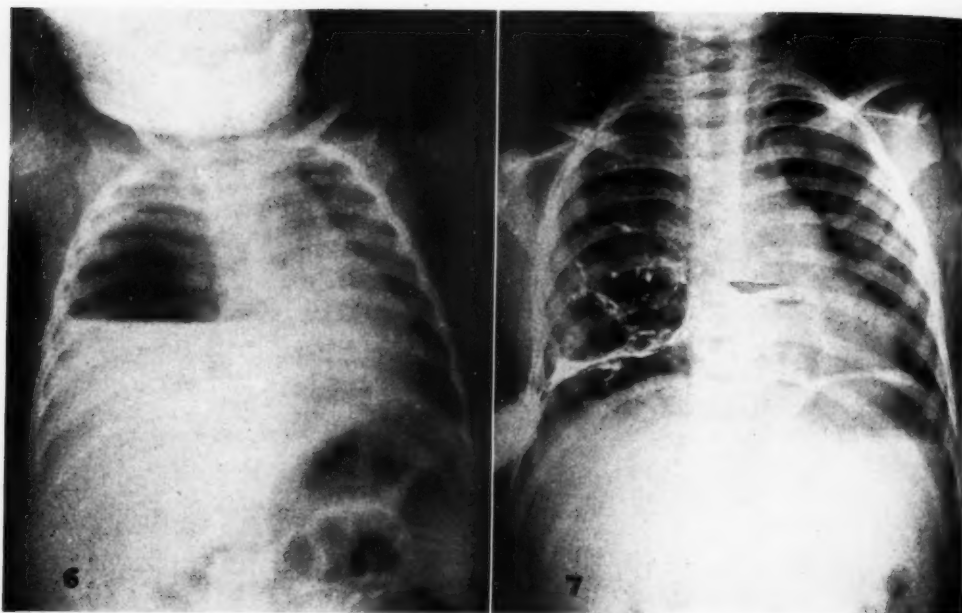
*Comment:* There is no doubt of the congenital origin of the solitary cyst. King and Harris (5), reviewing the development of the lung in the embryo, quote Simpkins, who believes that the bronchi develop from small ramifications of solid endodermal tissue, which become canalized almost immediately. They are of the opinion that an unknown process interferes with this canalization, which is resumed in the solid mass of cells distal to the occlusion. The normal epithelium assumes normal secretory function, and, because there is no way for the egress of the secretion, a cyst is formed. When such a cyst empties its whole content, a pneumocyst is formed.

The mechanism of formation and mode of evolution of pneumocysts have been the subject of considerable speculation.

That they have bronchial communication is evidenced by their constant air contents. Peirce and Dirkse (6) believe that most pneumocysts are acquired. They feel that the occurrence of excavation in the lung following a pneumonia or a bronchopneumonia, with a propensity to cyst formation, should make one very cautious in rendering a diagnosis of "congenital cyst." Chronic bullous emphysema is another condition which may present a roentgenographic pattern of multiple air cysts.

Two kinds of congenital pneumatoceles present themselves: the non-expanding type, in which the air sac does not change in size during respiration (Figs. 4 and 5); the expansile form, or "balloon-cyst," which continues to expand, displacing the mediastinal structures and causing impairment of the respiration and circulation. Cysts of this latter type are often fatal in spite of treatment.

Once the pneumatocele is established,



Figs. 6 and 7. Case III. In Fig. 6 a fluid level is seen within the cystic cavity. The heart is shifted to the left, indicating increased intrathoracic pressure due to a check-valve mechanism. In Fig. 7 the multilocular aspect of this solitary cyst is demonstrated with the aid of iodized oil.

why should the sac continue to expand? The explanation commonly accepted is the check-valve mechanism, described by Chevalier Jackson (7), which permits air to enter freely into the cyst without corresponding egress. In the non-expansile form the bronchial opening is large enough to permit both entrance and exit of air. This particular form may be seen in adult life.

The case under discussion is an illustration of a non-expansile type of pneumatocele. The mediastinal structures showed no displacement during the phases of respiration, indicating that the air content was not greater than the atmospheric pressure. The patient was followed in the clinic during a period of one year and showed no distress except for occasional upper respiratory infection.

The following case illustrates the rupture of a cyst into a bronchus.

CASE III (Figs. 6-8). A. R., a Negro girl aged 8 months, was brought to the emergency service on July 3, 1940, because of a coughing episode and temperature elevation to 102° F. After admission, the

patient coughed continuously with a sudden discharge, by nose and mouth, of a profuse mucoid material. The respiration was rapid, and each expiration was followed by a deep grunt.

The child had been born after a normal labor and cried at birth. She was undernourished, and breath sounds over the right chest were suppressed. The roentgenograms demonstrated a fluid level at the base of the right lung. The heart was shifted to the left (Fig. 6).

The red blood count was 3,090,000; hemoglobin 50 per cent; white blood count, 16,150, (polymorphonuclear neutrophils, 61 per cent; lymphocytes 38 per cent; large mononuclears 1 per cent). Urinalysis and other laboratory findings were negative.

Thoracentesis was performed, and 112 c.c. of purulent material were removed. In spite of supportive treatment, the child continued to run a septic temperature, with dyspnea and spasmodic attacks of coughing.

On Aug. 13, 1940, an open drainage was performed by Dr. William Adams under local anesthesia. An incision was made over the ninth right rib in the postaxillary line, and about one inch of this rib was removed subperiosteally. An incision was made through the rib bed into the cyst cavity and a large amount of purulent material was aspirated. A piece of the wall of the cyst was removed for microscopic study. Two small rubber tubes were placed in the opening, which was approximately half an inch wide

and an inch in length. The outer wall of the cyst was sutured to the intercostal structure, thus marsupializing the cyst. No closure was made.

Following this, the temperature returned to normal and the patient's condition improved; her appetite was better, and the cough and dyspnea disappeared. Roentgenograms made after injection of iodized oil demonstrated a multilocular cyst. The heart was still displaced to the left side (Fig. 7).

Microscopic sections of the cyst wall showed a vascular fibrous tissue, with numerous cystic spaces lined with cuboidal or low columnar epithelium among the vascular channels. Scattered in the fibrous stroma were many round cells and some polymorphonuclear leukocytes (Fig. 8).



Fig. 8. Case III. Cuboidal epithelium lining the cystic spaces.

*Comment:* This case is instructive both from the point of view of diagnosis and treatment. It shows that, although the history and physical findings are not pathognomonic of this condition, they may lead the clinician to the diagnosis. The recurrent attacks of a productive cough, the toxemia, the dyspnea and cyanosis, which are respectively the result of infection and intrathoracic changes, are suggestive of congenital cystic disease of the lungs. The case further demonstrates that when the roentgenograms reveal a large solitary

cavity with a fluid level, particularly in children, the possibility of congenital cystic disease of the lung should be kept in mind. Thoracentesis did not alter the course of the disease, but thoracotomy and drainage were followed by dramatic improvement, due to the cessation of the toxemia and disappearance of pressure within the cyst.

The child has developed well but will be kept under observation until she reaches an age when a lung resection may be the method of choice.

#### CONCLUSIONS

1. Three cases of congenital cystic disease of the lung are reported.
2. The first type, cystic disease proper, called also congenital bronchiectasis, may be latent for years, until infection leads to its discovery. The patients are mostly adults, and the prognosis is favorable. In the case recorded in this paper, the cysts were confined to one lobe of the lung, and lobectomy was considered the treatment of choice.
3. The "fluid cyst" may partially dis-

charge its contents into the bronchi, in which event the presence of air and fluid, demonstrable on the roentgenogram, will simulate a pleural effusion. Or the entire contents may be evacuated, resulting in a pneumocyst, which must be differentiated from acquired cyst and from pneumothorax.

4. When a check-valve mechanism permits air to enter the lung freely, without corresponding egress, the roentgenogram shows displacement of the heart and mediastinal structures; dyspnea and cyanosis are the most frequent symptoms. If the bronchial opening is large enough to permit both ingress and egress of air, the mediastinal structures are not displaced, and dyspnea and cyanosis do not occur.

5. The prognosis is influenced by two factors: the age of the patient and the presence or absence of complications. Children do not respond well to thoracic surgery, and in them the prognosis is poor. In adults treatment is far more successful. Infection and intrathoracic pressure are

the most serious complications. In their absence the prognosis is more favorable.

6. Treatment consists in supportive measures, thoracentesis, permanent drainage, and lung resection.

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## The Normal Lateral Retrograde Pyelogram<sup>1</sup>

MAJ. JAMES M. DELL, JR., M.C., A.U.S., and MAJ. COLUMBUS H. BARNWELL, M.C., A.U.S.

THE PURPOSE OF this paper is to present the position of the kidney as found in a series of lateral pyelograms, to determine the normal variation in position, and to assess the effect upon it of slight degrees of rotation. The justification for the study was an attempt to establish a normal that would be of value in determining abnormal forward displacement of the kidney by retrorenal growth or abscess.

The roentgen signs of significance in perinephric suppuration are: (1) loss of outline of the psoas muscle shadow; (2) absence of perirenal fat; (3) fixation of the kidney as seen in the upright position, and failure of the kidney to move with deep respiration; (4) scoliosis, indicating muscle spasm; (5) forward displacement of the kidney in the lateral pyelogram as reported by Menville (1).

Philip Shambaugh (2) found 24 cases of puzzling extra-renal masses in the left flank. It was important in these cases to determine whether the mass was intra- or extra-peritoneal. If the kidney was displaced, the evidence pointed to an extra-peritoneal mass; if the position was normal, the mass was probably intraperitoneal. Lateral pyelograms should be of great aid in this type of case. Forward displacement of a kidney could not be caused by an intraperitoneal mass.

To determine forward displacement, it is essential that we know the normal and its variation. It was with this thought in mind that the present study was made. The cases studied presented a variety of conditions: nephrolithiasis, pyelectasis, caliectasis, enuresis, tuberculosis, pyelonephritis, etc. In each instance retrograde pyelograms were obtained in anteroposterior and lateral recumbent projections. Only one kidney was injected in each case—the down kidney in the lateral film. Five

cases were studied with various degrees of rotation from the true lateral, from 10° to 40° anteriorly and the same posteriorly. Three cases were studied in the recumbent lateral, the 45° from the perpendicular lateral, and the upright lateral positions. The kidneys in these cases showed a rather marked descent in the upright position. A total of 35 patients were studied; in 15 the observations were made on the left kidney, and in 20 on the right.

Thirty-one of the 35 subjects showed the tip of the inferior calix at a level above the lower margin of the body of the second lumbar vertebra. Twenty-eight of the 31 showed the calices and pelvis within the shadow of the first and second lumbar vertebral body and 3 within the shadow of the twelfth thoracic and first lumbar bodies. Except for one case with a large dilated pelvis, none of the 31 showed any projection of the pelvis or calices anterior to the anterior border of the vertebral bodies. In the one exception, the pelvis extended from the posterior border to a point 3 cm. anterior to the anterior border.

Figure 1 (Case I) illustrates the average position in the 31 cases. A composite tracing of the group was made, but there were so many overlapping lines that it was not used. Figures 2-5 show the position in the remaining 4 cases. Tracings are used because of the difficulty in procuring clear prints from the roentgenograms.

Figure 2 is from a case of actinomycosis in the right flank with a draining sinus (Case II). There was a mass in the right flank apparently too far lateral to be connected with the kidney, but retrograde pyelograms were made for confirmation. The lateral pyelogram shows the kidney apparently displaced forward. The patient was operated upon, and a sinus tract was followed to a mass in the abdominal

<sup>1</sup> From Battey General Hospital, Rome, Ga. Accepted for publication in September 1945.



Fig. 1. Case I: The average position of the kidney in 31 cases.

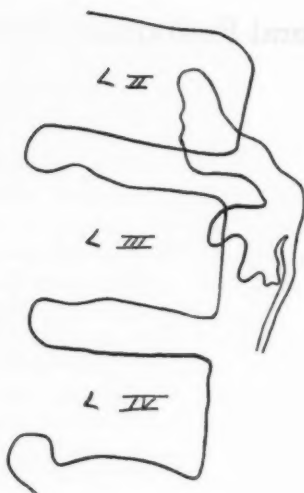


Fig. 2. Case II: Actinomycosis in the right flank.

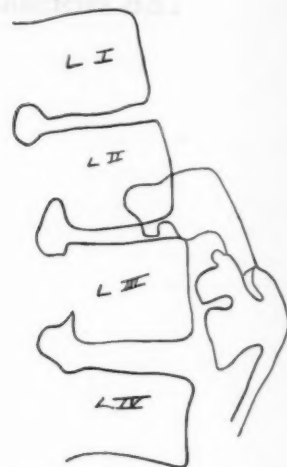


Fig. 3. Case III: Bifid pelvis with pyelectasis.

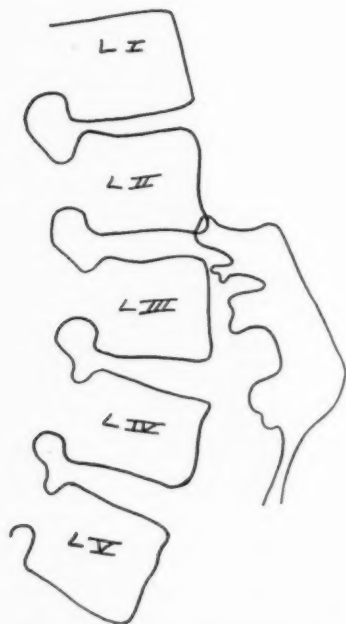


Fig. 4. Case IV: Prostatitis with pyuria.

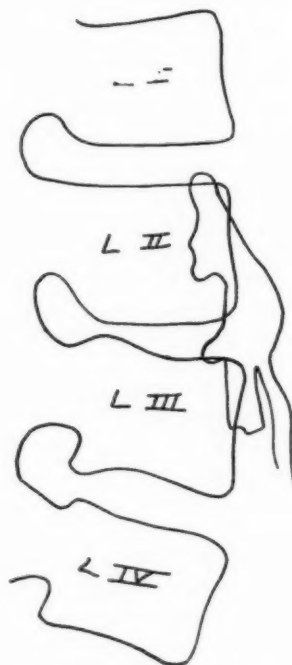


Fig. 5. Case V: Enuresis without demonstrable urinary disease.

wall composed of hard cartilaginous material. The right kidney was explored and no abnormality was found. The pelvis and calices are seen in the tracing to lie at a low level.

Figure 3 is from a case of bifid pelvis with a pyelectasis (Case III). Note the anterior position of the kidney at this level. This patient was operated upon and an aberrant vessel was severed and ligated. No retrorenal mass was found.

Figure 4 (Case IV) shows the position of the kidney in a case of pyuria due to prostatitis. The pelvis and calices are at a level from the lower quarter of the body of the second to the upper border of the body of the fourth lumbar vertebra. The pelvis and calices of this kidney are anterior to the anterior border of the vertebral bodies. The other kidney in this case occupied the usual level and was posterior to the anterior border of the vertebral bodies. In this presentation the word kidney refers to the calices and pelvis as outlined by the opaque media.

Figure 5 is from a patient with enuresis without demonstrable urinary disease (Case V). This shows the forward position of a kidney located at a slightly higher level than in the three preceding cases. No operation was done in Cases IV and V.

The three cases studied in the recumbent, 45° erect, and erect positions showed the kidney descending an average of 9 cm. As the kidney descends, it lies progressively further forward and the upper pole is rotated posteriorly.

In the more muscular subjects, the kidney was found to lie slightly more anterior, but the difference was not enough to change any of the conclusions from this study.

Ten degrees of forward or posterior rotation will not cause change of position of any consequence. Posterior rotation of the up side will tend to place the kidney of the down side in a more anterior position relative to the spine. Anterior rotation will produce a reverse effect. Rotation can

usually be determined by the relative position of the ribs. Films showing moderate rotation should not be used.

Acceptable films with rotation are those which show the up side ribs not over one inch anterior or posterior to the down side ribs. This is determined from the posterior portion of the ribs. Moderate rotation is any beyond the one inch mentioned above.

#### CONCLUSIONS

A kidney lying between the level of the twelfth thoracic and the lower border of the second lumbar vertebral bodies should not project beyond their anterior borders unless the pelvis is moderately dilated. A moderate or even large renal pelvis located at the usual level will have its posterior border at the same vertical level as the posterior border of the vertebral bodies. Thus, anterior displacement would be easy to determine by the forward displacement of the posterior border of the renal pelvis. Minor degrees of pelvic enlargement do not normally project beyond the anterior border of the bodies.

The posterior border of the superior calix lies from 2.0 to 3.5 cm. posterior to the posterior border of the inferior calix. This indicates that a position of the superior calix approaching that of the inferior calix in the vertical plane may be of importance.

The measurements of the four kidneys located at lower levels indicate the expected anterior position in these few cases.

It is believed that this information may be of value in the diagnosis of retrorenal abscess or tumor.

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## Measurement of Resolving Power of Intensifying Screens<sup>1</sup>

WILLARD W. VAN ALLEN<sup>2</sup> and RUSSELL H. MORGAN, M.D.<sup>3</sup>

ONE OF THE MORE important characteristics which determine the interpretative value of a roentgenogram is the ability of the film or film-screen combination to record detail. A quantitative measure of this characteristic, therefore, is needed in order to evaluate accurately the various types of screens and films available to the radiologist, as well as to assist in determining the optimum conditions of technic. Because of difficulties to be mentioned later, satisfactory methods of measuring this ability to record detail have not previously been developed. In this article such a method is described and the results obtained with a number of commercial screens are tabulated.

In the case of photographic materials, the procedure has been fairly well standardized. It consists of photographing on the material to be tested, either by contact or projection, a test object such as that shown in Figure 1, containing a series of alternate lines and spaces of different width. The number of lines per millimeter which can be distinguished on the processed material, then, is a measure of the ability to record detail and is called *resolving power*. If the test object is photographed, the resulting figure for resolving power will be a measure of the resolving power of the lens-film combination and will not be greater than that of either component alone. The same applies to printing by projection. If the test object is printed by contact, the result will be the resolving power of the emulsion alone. In general, therefore, the resolving power recorded by any emulsion is limited by that factor of the optical-photographic system having the lowest resolving power.

It has been shown (1) that the resolving power obtained by these methods depends

upon a large number of factors other than the photosensitive material itself, namely, (a) the line-space ratio of the test object, (b) test object contrast, (c) level of illumination, (d) development time, (e) wave length of light, (f) composition of the developer, (g) developer concentration, (h) developer temperature, (i) reduction and intensification, (j) dyes. Obviously, therefore, any determination of resolving power must be made under carefully standardized conditions if the results are to be comparable and reproducible. The first of these factors, the line-space ratio, has been generally fixed at 1; that is, the lines and spaces are of equal width. The other factors are easily controlled or are dictated by the technic and therefore determined by the conditions of test. Thus, in x-ray procedures, the wave length of the radiation is determined by kilovoltage, character of structure being radiographed, and type of intensifying screen used; dyes are encountered only as they are incorporated in different types of films.

The difficulties in determining the resolving power of x-ray materials—film alone, film-screen combinations, or lens-screen-film combinations—arise primarily in the preparation of a suitable test object. While it is theoretically possible to prepare a test object of alternate strips of lead and intervening spaces to take the place of the black and white ruled lines used in photography, the practical difficulties encountered in making such an object are enormous. Resolution measurements of x-ray materials have been made (2) with considerable success by use of a test object consisting of a mandrel on which are wound several turns of silver wire of different diameters, the resolving power of the material or system being expressed as

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the maximum number of "serrations" per millimeter which could be distinguished in the developed image. The shape of the silhouette so obtained, however, is such that the unsharpness characteristic of the emulsion tends to obscure the serrations by "filling in" the valleys between them and thus to obscure the pattern in such a way as to limit its value in determining the true resolving power. Furthermore, as is

produced by photographic procedure, a device is required which will produce lines of any desired width separated by unexposed spaces of the same width. For example, if an image is to be produced, composed of five lines per millimeter, each line must be 0.1 mm. wide and the intervening spaces 0.1 mm. wide so that the total width of a single line and space will be 0.2 mm. Again, if the line-group image

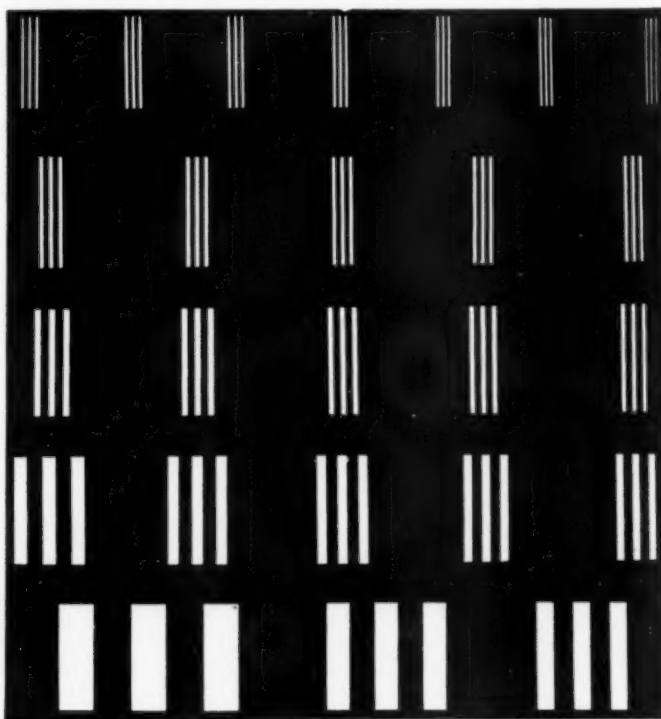


Fig. 1. Line drawing test object used in measuring the resolving power of photographic materials.

pointed out in more detail later, since the thickness of the wire decreases rapidly toward its edge, the mandrel test object has a high inherent unsharpness characteristic especially for radiation of high penetration. In an effort to avoid these difficulties and at the same time to obtain a measure of resolving power of x-ray materials comparable to that used in photography, the method described below was devised.

In order to produce a line-space pattern by x-rays of the same type as that

is to consist of ten lines per millimeter, the lines must be 0.05 mm. wide and the spaces 0.05 mm. wide, giving a total width for one line and one space of 0.1 mm. In general, therefore

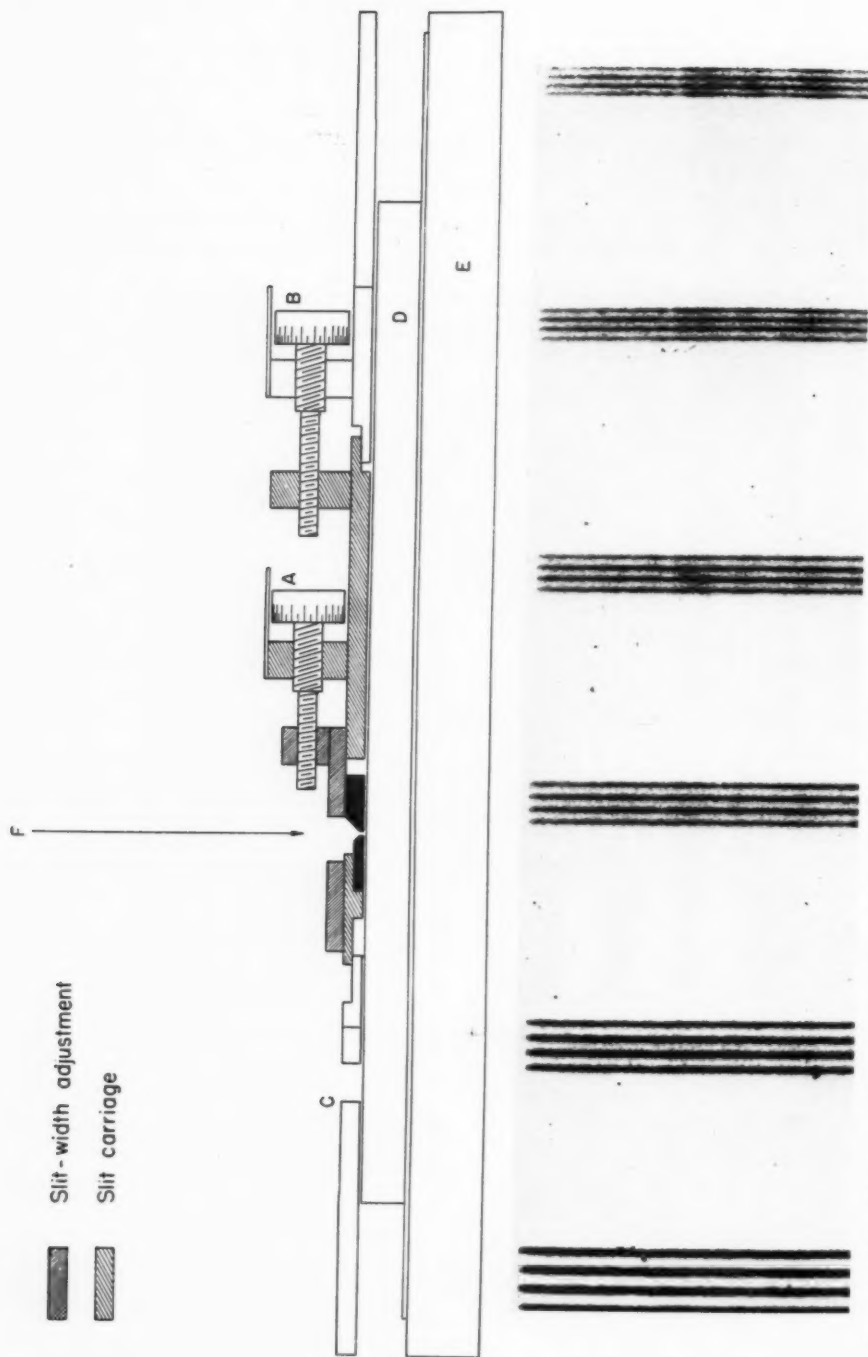
$$w_1 = w_s = \frac{1}{2n} \text{ and } w_1 + w_s = \frac{1}{n}$$

where

$w_1$  = width of a line

$w_s$  = width of a space and

$n$  = number of lines per millimeter.



Figs. 2 and 3. Diagram of slit mechanism used in measuring the resolving power of x-ray films and screens and typical series of line-group images obtained from an x-ray screen-film combination by the use of this system. A. Differential screw which adjusts the width of the slit. B. Differential screw which moves the slit system laterally. C. Test exposure port. D. Cassette. E. Table. F. Direction of x-ray beam.

These requirements will be met by a device having a slit of adjustable width formed between two blocks of a radiopaque alloy and a mechanism by which this slit system may be moved laterally between exposures a distance equal to twice the width of the slit. Then, if a film is given an x-ray exposure through such a slit, the slit system is moved laterally twice its width, and another exposure is made, and so on, an image will be obtained on the film consisting of a group of lines separated by unexposed spaces of the same width as the lines. This pattern is obviously the same as that obtained by photographing a ruled test object by conventional photographic methods. To produce an image-group of  $n$  lines per millimeter, therefore, the slit must be adjusted to a width of  $1/2n$  mm. and the slit system moved  $1/n$  mm. between successive exposures.

The apparatus, shown diagrammatically in Figure 2, consists essentially of a slit system formed by two lead alloy blocks mounted on a carriage which can be moved laterally by means of the differential screw *B*. The width of the slit can be adjusted by means of the differential screw *A*. The port *C* allows an exposure to be made on the film under the same conditions that are used for the line-group images, so that the results may be interpreted in terms of the density produced in a large "spot" by the same exposure factors used in producing the line-group image. The whole mechanism rests on the cassette *D*, in which are placed the screen and film under examination.

In use, the slit system is adjusted to a width corresponding to slightly fewer lines per millimeter than the expected resolving power of the film or film-screen combination being tested; then an exposure is made. Next, the slit-system is moved twice the width of the slit and another exposure is made, and so on until a group of four or five lines is produced. The slit system is then adjusted to correspond to a higher resolving power by narrowing the slit, and another series of

exposures is made as above. This procedure is repeated until a series of line-group images has been made, including the expected resolving power of the film or film-screen combination. The film is processed and examined under low magnification, the resolving power being taken as the number of lines per millimeter in that group of exposures in which the lines are just distinguishable. An enlarged view of a typical series of line-groups is shown in Figure 3. It was found that the results were not affected by the size of the focal spot nor by the addition of collimating ports between the tube and the slit. It was necessary, however, to take precautions in aligning the tube and slit to insure that the rays enter the slit in a direction perpendicular to its plane so that the effective width of the slit is not reduced by parallax.

With the use of the apparatus as described above, a series of exposures was made employing a number of commercially available screens and films at 30 kv.p. with no added filtration, 50 and 60 kv.p. with 2.0 mm. aluminum filtration, 70 kv.p. with 4.0 mm. aluminum, 90 kv.p. with 0.5 mm. copper, and 100 kv.p. with 1.0 mm. copper, corresponding, respectively, to half-value layers of 0.45 mm., 1.76 mm., 2.0 mm., 4.0 mm., 6.8 mm., and 10.0 mm. aluminum. No difference in the resolving power of these screens was found under the various conditions of radiation wave length, and, consequently, further tests were confined to radiation at 60 kv.p. with 2.0 mm. of aluminum. Resolving power measurements were made at exposures resulting in "spot" densities ranging from 0.1 to 2.8 above base and fog and under normal processing conditions. Blue-sensitive film was used for blue-fluorescent screens and green-sensitive film for green-fluorescent screens. The resolving powers of these films alone, *i.e.*, without screens, were found to be considerably greater than the resolving power of the screen-film combinations. Therefore, measurements of the screen-film combinations give essentially the resolving power of the screens themselves.

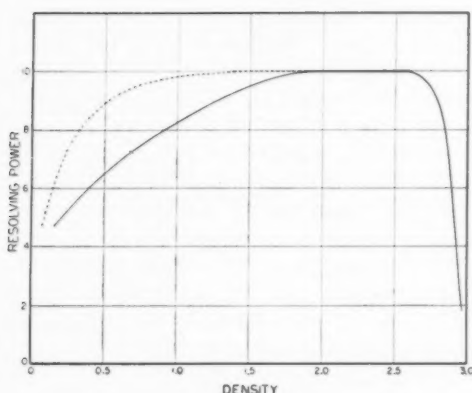


Fig. 4. Relationship between resolving power and density for a typical x-ray film-screen combination. "Spot" density vs. resolving power is shown by the solid line; calculated image density vs. resolving power is shown by the broken line.

The maximum resolving powers of the screens tested are tabulated in Table I. It is interesting to note the striking similarity in resolving power not only of screens of different manufacturers, but even of screens of the same manufacturer rated by him as "high-definition," "medium-speed," and "high-speed," since in general it would be expected that high-speed screens, with their coarser grain structure, would show an appreciably lower resolving power than the finer-grained "high-definition" screens. It appears that only one "high-definition" screen (C) possesses a significantly greater resolving power than the average screen. From the standpoint of resolving power alone, therefore, there seems to be little to recommend one screen over another except in the one instance. A typical graph of resolving power in relation to "spot" density is shown in the solid line in Figure 4. It is seen that the resolving power rises to a maximum at a spot density of about 1.9, remains constant at this maximum to a spot density of about 2.6, and then falls off rapidly.

As mentioned above, resolving power was found to be independent of the wave length of the x-radiation. Morgan (2), using the wire-wound test object, found that the resolving power dropped off as the wave length of the radiation decreased.

TABLE I. RESOLVING POWER OF COMMERCIAL SCREENS ACCORDING TO TYPE AND MANUFACTURER

Type of Screen	Manufacturer		
	A	B	C
High definition	12 $\frac{1}{2}$	10	17 $\frac{1}{2}$
Medium speed	12 $\frac{1}{2}$	10	10
High speed	10	9	..
Industrial	..	6	..
Fluorographic, blue-fluorescent	7		
Fluorographic, green-fluorescent	6		

This discrepancy can probably be explained by the fact that the silver wire used in making Morgan's test object is not entirely radiopaque, absorbing less radiation as the wave length decreases, and by the fact that the thickness of the wire is not uniform but decreases rapidly toward the circumference. For these reasons the silhouette produced by this type of test object is less sharp than it would be if the object were of uniform thickness and of greater opacity to x-radiation. Thus, at the shorter wave lengths, the image will not only show a greater unsharpness, but the effective diameter of the wire will be less, due to penetration of the thinner edges by radiation of shorter wave lengths. The same size wire thus appears smaller and less sharp at the shorter wave lengths, so that the serrations, although distinguishable at exposures of longer wave lengths, become indistinguishable when the radiation is more penetrating. These conditions do not prevail with the mechanism described above, since the edges of the slit are thick enough to be radiopaque at all wave lengths used. In this connection it might perhaps be argued that spurious results could be obtained from radiation scattered by the edges of the lead slit. That this is not the case is shown by the fact that no differences in resolving power were obtained after careful collimation of the x-ray beam before it entered the slit. Furthermore, since the width of the slit is very small compared with the thickness of the edges, the effect of the slit is to collimate its own beam; any radiation scattered at the entrance is absorbed by the opposite wall.

The results discussed above and shown

graphically by the solid line in Figure 4 give the resolving power of the screen-film combinations as observed in an image consisting of a group of lines on an unexposed background, plotted against the density produced in a relatively large spot by the same exposure. If the density of each line were equal to that of the spot and the spaces between the lines were clear, this curve would represent the relationship between resolving power and image contrast. Unfortunately, this ideal condition does not prevail, as will be apparent from the following considerations of the characteristics of a line-group image.

The film blackening is due almost entirely to light received from the screen, that due to direct x-radiation being negligible. The amount of light produced by the screen is the result of direct excitation by incident x-rays through the slit, plus excitation due to x-rays scattered by the screen itself, plus excitation due to the luminescence of adjacent crystals of the screen. The intensity of the light produced by the first of these effects, the direct absorption of the primary radiation, is independent of the width of the slit, but the intensity produced by scattered radiation in the screen and self-excitation is not. As the width of the slit decreases, the amount of radiation scattered by the screen decreases, as does the excitation of the screen by its own luminescence. These effects combine to produce a much lower total brilliance for narrow slits than for wide slits, even though the incident radiation remains constant. Hence, as the width of the lines decreases, the density of each line also decreases, so that the density of a line approaches that of the large spot only for lines of considerably greater width than those in an image at the maximum resolving power. In other words, the *exposure-density*, measured in the spot, is greater than the actual image density, except for very wide lines. It is evident, therefore, that the *contrast* between the line-group image and the background is not the same as the contrast between the control spot and the background.

Furthermore, as the lines are brought closer and closer together, the unexposed "clear spaces" between them are more and more encroached upon by the diffuse density due to the unsharpness characteristic of the line images so that, even before the limit of resolution is reached, these unexposed spaces are no longer clear. This merging of the regions of unsharpness, as the space between the lines decreases, builds up the density in the spaces until, at the limit of resolution, the density in the spaces is so nearly equal to that of the lines themselves that their individuality can no longer be distinguished, since the contrast has dropped to zero. This image, however, was produced by alternate equally exposed and unexposed areas, so that the density produced in the line-group image at the limit of resolution is the same as the density which would be produced in a spot of equal size by one-half the exposure. If the resolving power is plotted against the density produced by one-half the exposure, as calculated from the *D-log E* curve of the film, there results the curve shown by the broken line in Figure 4, a curve more closely approximating a graph of photographic resolving power *versus* contrast.

In the foregoing discussion, only images produced by a test object of infinite contrast have been considered. In practical roentgenography, detail is almost invariably recorded as differences in density produced through selective absorption of radiation as it passes through tissues or other material under examination and hence almost never approaches the ideal provided by a test object of infinite contrast. The practical radiologist, therefore, is more interested in the resolving power of a screen-film combination at different *exposure-contrasts* and different density levels than in the maximum resolving power under conditions of infinite contrast. Obviously the *exposure-contrast* is determined by the quality of the radiation and the nature of the subject, and the density of the image is determined by the exposure. It is important to determine, therefore, the optimum conditions of wave length

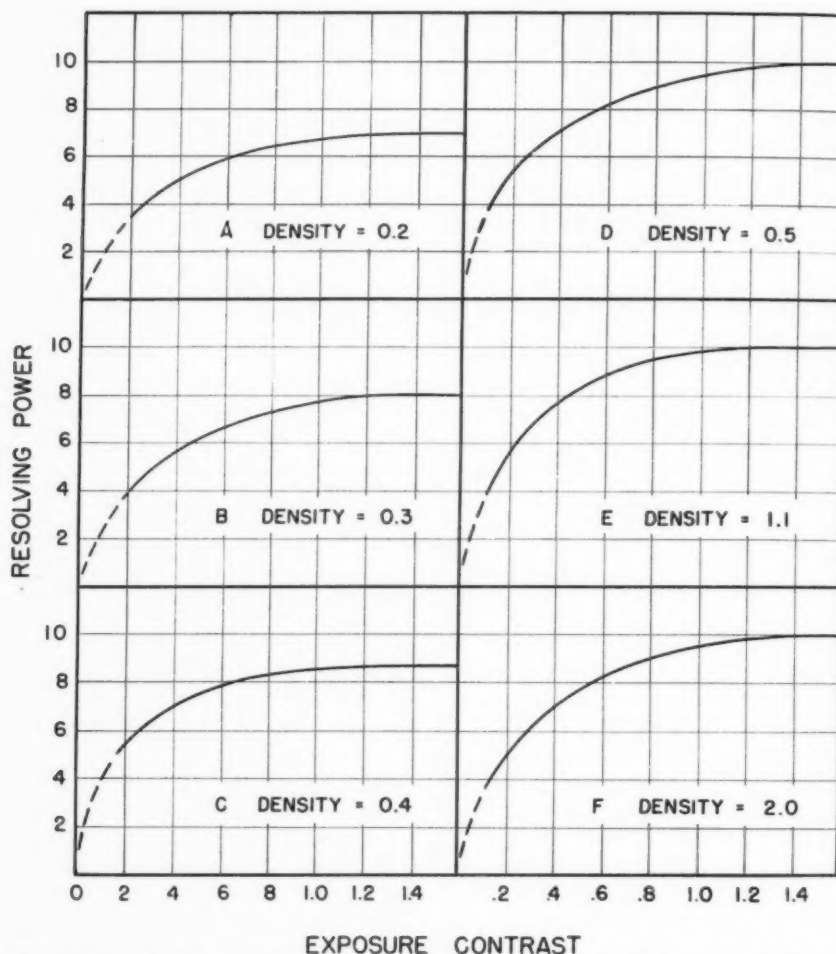


Fig. 5. Relationship between resolving power and exposure contrast at different total densities for a typical film-screen combination having a maximum resolving power of 10 lines per millimeter.

and exposure (*i.e.*, exposure contrast and density) which will give the greatest possible resolution for a given type of material.

In order to determine the resolving power at different densities and exposure contrasts, a series of tests was made on screens having a maximum resolving power of ten lines per millimeter, in which the film was first given a uniform pre-exposure, after which it was exposed through the slit as described above. In each series, the exposures were calculated to give the same total image density, so that gamma could be considered essentially constant

for the series, while the exposure contrast was varied. That is, if an exposure  $E_0$  is required to produce a density of, say, 1.0, and  $E_1$  is the pre-exposure, the second exposure through the slit must be

$$E_2 = 2(E_0 - E_1)$$

since, at the limit of resolution, the density produced in a line-group image is equal to that produced by one-half the exposure, as discussed above. The total density in the example given, then, is 1.0 and the exposure contrast can be varied and will equal

$$C = \log(E_1 + E_2) - \log E_1$$

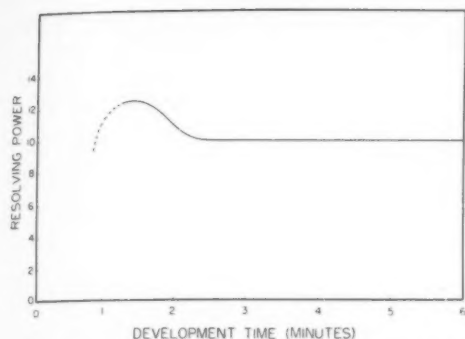


Fig. 6. Relationship between maximum resolving power and development time for a typical film-screen combination.

The results, for six different total density values, are shown in Figure 5. It is seen that for low densities, that is, up to and including 0.4, the maximum resolving power increases with density, but does not reach the maximum of ten lines per millimeter of which the screen is capable. At densities of from 0.5 to 2.0, the maximum resolving power is attained at minimum exposure contrasts varying from 1.1 at a density of 1.1 (*E* in Fig. 5) to 1.4 at densities of 1.0 and 2.0 (*D* and *F*, Fig. 5). Furthermore, if the exposure contrast in a given problem is necessarily low because of the nature of the material under examination, the greatest resolution appears to be given at an image density in the neighborhood of 1.0, since the curve of resolving power at that density (*E*, Fig. 5) rises most rapidly, indicating the greatest resolving power at a given exposure contrast of any in the series. The radiologist interested in maximum detail will, therefore, choose kilovoltage and exposure so that exposure contrast and density will approximate, as closely as possible, the values indicated by these curves.

The equation

$$R = R_{max} (1 - e^{-aD})$$

has been suggested (1) as representing the relationship between resolving power and test object contrast, where  $R$  is the resolving power for any test object contrast  $D$ ,  $R_{max}$  is the maximum resolving power,  $D$  is the test object contrast, and  $a$  is a con-

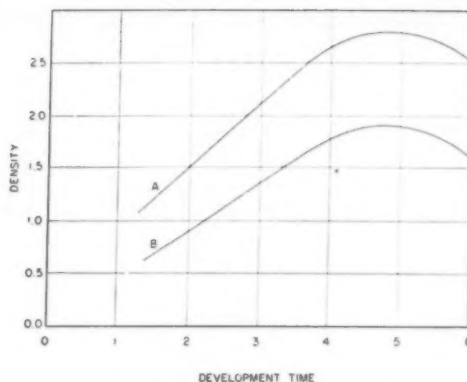


Fig. 7. Range of "spot" densities in which the resolving power is a maximum at different development times. Curve A shows the maximum and curve B the minimum density at which the resolving power is maximum.

stant. Although in these x-ray studies it is not possible to vary the contrast of the test object itself as in photography, the exposure contrast, which is identically equal to test object contrast, was varied as described above. Attempts to fit this equation, with  $D$  equal to exposure contrast, to the results obtained for resolving power as a function of exposure contrast result in curves which vary systematically from experimentally determined values for any value of  $a$ . This would seem to indicate that the equation does not adequately describe the relationship between resolving power and exposure contrast. Further studies are necessary, therefore, to discover a satisfactory equation connecting these quantities.

The effect of development time on maximum resolving power was investigated with results shown in Figures 6 and 7. Figure 6 shows that, for extreme overexposure and very short development, the resolving power is somewhat greater than the maximum obtained under normal processing conditions, but that otherwise the maximum resolving power is not affected by over- or underdevelopment.

Figure 7 shows the range of "spot" densities in which the maximum resolving power occurs as development time increases. Curve A is the maximum density and curve B the minimum density at

which the resolving power is at the maximum. It is interesting to note that as the development time increases, the density at which maximum resolving power occurs first increases and then falls off under conditions of overdevelopment, reaching its peak at approximately normal development time. Thus the resolving power under conditions of overexposure and underdevelopment is a maximum at densities considerably lower than those required for maximum resolving power under normal conditions of development. On the other hand, the maximum resolving power occurs throughout the greatest range of densities under conditions of normal exposure and development.

#### SUMMARY

Apparatus and method for measuring the resolving power of x-ray films and film-screen combinations have been described.

The resolving power of several commercial screens has been measured and the results are tabulated.

The relationship between resolving power and density has been investigated.

The relationship between resolving power and exposure contrast at different density levels has been studied, and on the basis of these results, technic for maximum detail is discussed.

The effect of development time on resolving power has been investigated.

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## Roentgen Findings in Erythema Nodosum<sup>1</sup>

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THE ETIOLOGY of erythema nodosum is not specific, since it is believed that it may be caused by almost any infectious disease. Apparent outstanding sources are rheumatic fever, tuberculosis, syphilis, and infections caused by the gonococcus and meningococcus.

Histologic examination of the lesions of erythema nodosum shows that there are dilatation of the capillaries and extravasation of serum, leukocytes, and erythrocytes into the surrounding tissues. The bruised appearance assumed on healing is due to the disintegration of red blood cells.

The eruption consists of poorly defined, nodular lesions varying in diameter from a few millimeters to 5 or 6 cm. The lesions are prone to appear on the shin but may occur on any of the extremities or on the buttocks. The overlying skin is smooth, shiny, and generally of a rose red color. Ulceration seldom takes place; the nodules appear in crops, last from a few days to several weeks, and slowly disappear (1). The eruption is usually preceded by mild constitutional symptoms, as fever, malaise, and pain in the muscles and joints, and is sometimes accompanied by definite polyarthritis.

In treatment of these cases, emphasis should be placed on determination of the underlying etiologic factors and their correction or removal. Tests for sensitivity to tuberculin, streptococcus protein, and coccidioidomycin should be performed. A number of the streptococcus-sensitive patients have proved to have rheumatic fever (2). Analgesics, especially salicylates, are useful when the eruption is accompanied by pain. Soothing lotions may be applied.

A white male, age 22, height 6 feet 7 3/8 inches, weight 240 pounds, gave a childhood history of measles, mumps, pertussis, and scarlet fever. He had

a right inguinal hernia repaired at the age of two. His mother and father, three sisters, and six brothers were living and well. A maternal aunt had died of pulmonary tuberculosis.

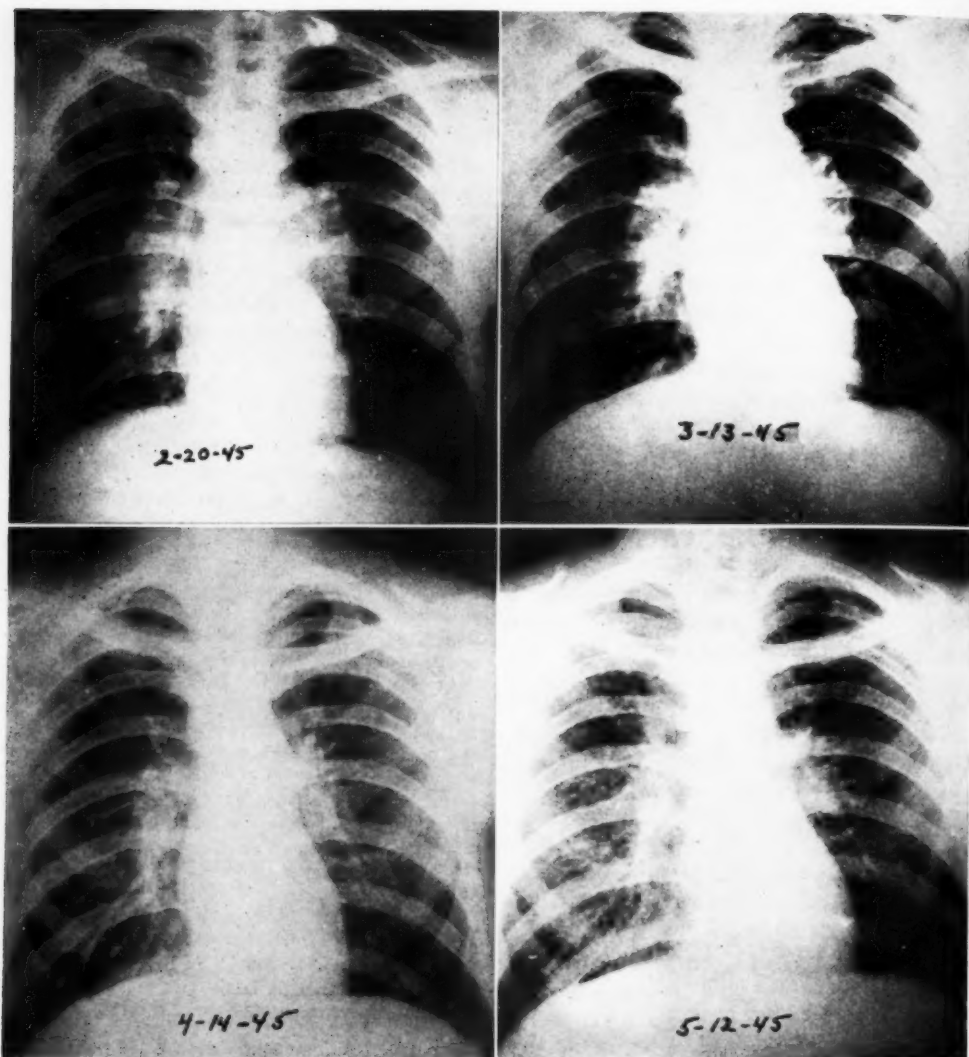
At the age of eighteen, the patient had begun working in a fire-brick mill, an occupation which entailed exposure to minimal amounts of chrome and magnesium dust. He wore a respirator for only two weeks, while working on a detail sifting silica dust. His main assignment for twenty months was on the maintenance crew, repairing pipes crossing above the kilns which were covered with silica dust, to which he was thus occasionally exposed. During this occupation he suffered one attack of heat exhaustion of a week's duration, but no other illness. At the age of twenty he was inducted into the Army and his assignment as aircraft mechanic was fulfilled with no illnesses until December 1944.

For approximately two months the patient experienced occasional pain in the arch of the right foot. In February 1945, the pains became more severe, and headaches and coryza developed. Later, pains occurred in the left ankle and knee and the interphalangeal joints of the left middle and ring fingers. At this time bilateral, symmetrical, tender red nodules, about 2 inches in diameter, appeared over both pretibial areas. The throat became inflamed, the cervical nodes were swollen and tender, and there were tenderness, redness, and increased temperature of the left ankle and knee.

The patient was hospitalized and salicylate therapy was given, producing some relief of the joint pain. During February and March the temperature ranged from 100° to 103°, but remained normal after April 1945.

A chest film taken Feb. 20, 1945, showed massive hilar nodes and accentuation of the bronchovascular markings. The possibilities of a lymphoblastoma and of a primary tuberculous adenitis were considered. By the end of February, the redness, swelling, and tenderness of the pretibial areas began to subside, but the roentgen signs in the chest persisted. The rash had completely disappeared by the end of March, but at this time further enlargement of the hilar areas was demonstrable roentgenologically, with a small amount of radiating, mottled infiltration extending out from each hilus. The possibility of sarcoid was now suggested, but x-ray examination of the hands and feet showed no evidence of bone involvement and there were no typical sarcoid skin lesions. A chest film taken April 14, 1945, showed diffuse miliary and linear involvement of the periphery of the lung fields with a slight regression in the size of the hilar and mediastinal nodes. Considerable parenchymal involvement was still pres-

<sup>1</sup> Accepted for publication in October 1945.



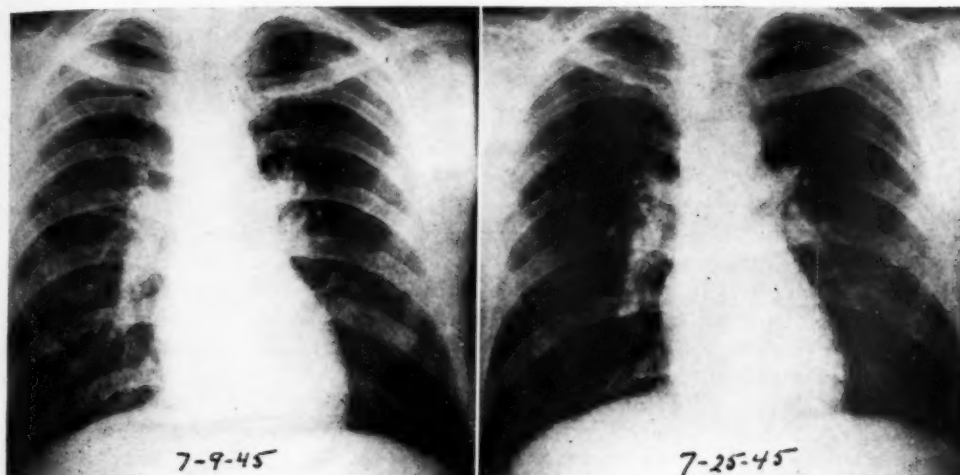
Figs. 1-4. Successive films showing pulmonary involvement in erythema nodosum.

ent on May 12, 1945. Further examination on July 9 showed almost complete regression of the mediastinal and hilar node involvement with minimal residual parenchymal involvement.

Various laboratory examinations were performed, beginning in February. Twelve sputum examinations were negative for tubercle bacilli. A heterophile antibody test and blood Kahn and skin tuberculin tests were also negative. Coccidioidomycosis was eliminated by several negative skin tests. The sedimentation rate was elevated to 43 mm. on Feb. 21, 1945, but remained normal after March. The highest leukocyte count was 13,000 on Feb. 21, with

74 per cent polymorphonuclears and 26 per cent lymphocytes. The red count varied from 4,170,000 to 4,760,000. Urinalyses were repeatedly negative. Electrocardiograms, in February, showed a relative increase in the P-R interval with the rate remaining constant and inverted T 3's. Electrocardiograms in July showed the P-R interval to be normal and the T 3's to be upright.

As intimated above, the differential diagnosis in this case was rather involved. Silicosis, coccidioidomycosis, rheumatic fever, tuberculosis, lymphoblastoma, sar-



Figs. 5 and 6. Later films of case shown in Figs. 1-4, showing regression of the lesions in the lungs.

coidosis, infectious mononucleosis, and erythema nodosum all entered into consideration. There has been observed an association of erythema nodosum with primary tuberculosis, acute coccidioidomycosis, and hemolytic streptococcal infection, presumably when cutaneous allergy to the products of these organisms is at a high level (2). Cases of erythema nodosum have been reported in connection with iodism, with sulfathiazole, and with other drug intoxications. Holt and McIntosh have seen the condition in association with chronic ulcerative colitis in patients failing to react to tuberculin or to streptococcal protein (2).

Sante (3) mentions that sarcoid or erythema nodosum may produce a roentgen appearance similar to tularemia pneumonia. The involvement may spread to the periphery of the lung and show miliary infiltrations resembling miliary tuberculosis, which, however, finally clear. Sante further states that in the nodular stage of silicosis there is a similarity to sarcoid, erythema nodosum, various forms of mycotic infection, and leukemia.

In view of the polyarthritides, electrocardiographic changes, and elevated sedimentation rate, all of which had disappeared at the time of this report, though there

was still residual fatigability, a diagnosis of rheumatic fever is most logical in the case here recorded. The erythematous spots on the legs, which developed in February and subsequently turned purple, and the enlarged hilar nodes and parenchymal involvement probably represent erythema nodosum with both skin and pulmonary changes on an etiologic background of rheumatic fever. The absence of bone or skin changes characteristic of sarcoidosis, the negative tuberculin and coccidioidomycin skin tests, the negative heterophile antigen tests, and the clearing of the pulmonary fields and reduction in size of the hilar nodes all favor a diagnosis of erythema nodosum.

The accompanying series of x-ray films illustrates the pulmonary changes throughout the observation period.

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## Versatile Erect Bucky for Private Office Radiography

With Description of Horizontal Bucky Table Mounted on Floor Track<sup>1</sup>

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**A**N ERECT Bucky, herewith described, has been found flexible and efficient for private office radiographic work. It is particularly helpful in radiography of shoulders and fractured ribs and in skull, sinus, mastoid, and mandible examinations. The effectiveness of the Bucky is increased by providing the radiographic room with a table which moves on casters over a floor track. Held in proper alignment by the track, this table is exactly centered with reference to the erect Bucky and the plate changer at opposite ends of the radiographic room. The position of the Bucky in relation to the radiographic table and plate changer is shown schematically in Figure 1.

Firmly fixed to the floor and wall, the vertical Bucky stand is mounted on two steel upright tubes which house a counterweight. The Bucky is of the 14 × 17-in. high-speed type and is mounted on two extension arms projecting from the center casting. This allows for 180° rotation, so that the bakelite face can be used as a table top for extremity examinations (Fig. 6). The rotation mechanism is controlled by a counterbalancing coil spring. The vertical moving mechanism is mounted on large ball bearings and accurately counterbalanced.

The erect unit is fitted with a special sinus tunnel for non-Bucky work, allowing for two exposures on an 8 × 10-in. cassette. This is shown in Figure 7. Our routine sinus examination consists of the following projections, all of which are made in the upright position after the manner suggested by Pendergrass (1): (a) Caldwell and Granger projection; (b) routine erect Waters position with mouth closed and Pirie projection made in an exaggerated Waters position with open mouth, to pro-

file the sphenoidal air cells; (c) stereoscopic postero-anterior oblique views of the ethmoidal capsules; (d) a single lateral film of the frontal sinuses, as well as a special lateral view of the antra and sphenoidal sinuses. In certain instances it is helpful to procure an anteroposterior film in the erect posture with the head tilted to right or left in order to demonstrate a shifting fluid level. We consider the erect posture extremely helpful in demonstrating mucocoeles and other types of mucosal thickening.

A cassette holder is available for long-distance cervical spine radiography. The holder is fitted over the bakelite face of the unit, thus accommodating any size of cassette up to and including a 14 × 17. This can be regularly used for all non-Bucky technics with or without a Lysholm grid and with any degree of angulation required.

The Bucky table is supported by heavy cast-iron legs, which provide both rigidity and stability. The legs are furnished with large hard rubber, ball-bearing casters. The casters on the tube-stand side of the table are grooved in order to follow the floor track, which controls the longitudinal movement of the table. The table is fitted with both a locking mechanism and interconnecting tube-stand lock.

The equipment described above is useful in the following examinations:

(a) *Conventional study of the cranium.* Erect positioning is often essential in obtaining an accurate submentovertex projection, or Bowen-Hirtz view of the base of the skull, since extension of the cervical spine is more readily accomplished in the upright position. Also in the anteroposterior projection of the foramen magnum, with the central ray directed from the hairline to the base of the skull (Towne projection), flexion of the cervical spine is

<sup>1</sup> Accepted for publication in October 1945.

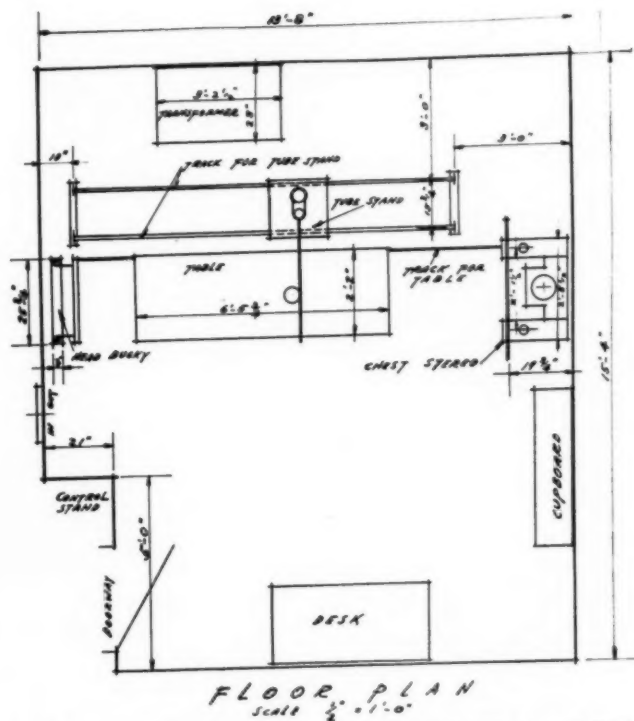
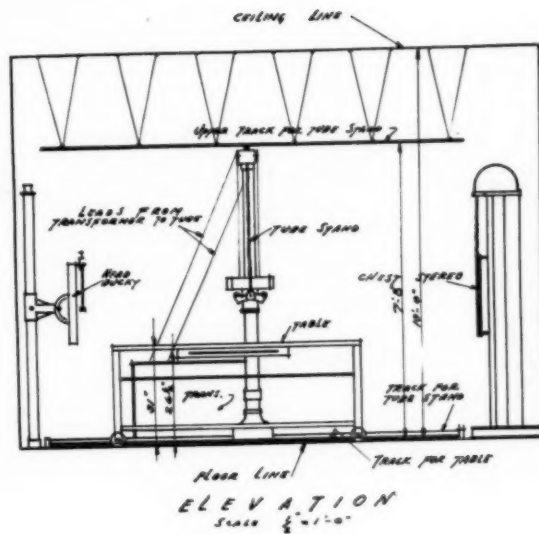


Fig. 1. Floor plan of x-ray room showing relationship of horizontal table to erect Bucky on the left and the plate changer on the right. Note track for tube stand and single track for table. The horizontal Bucky table can be pushed to either end of the room to allow for adequate working space at either erect Bucky or plate changer. (Original floor plan designed by Mr. William Hogan, Franklin X-ray Company, Philadelphia. Drawing by R. W. Reynolds.)

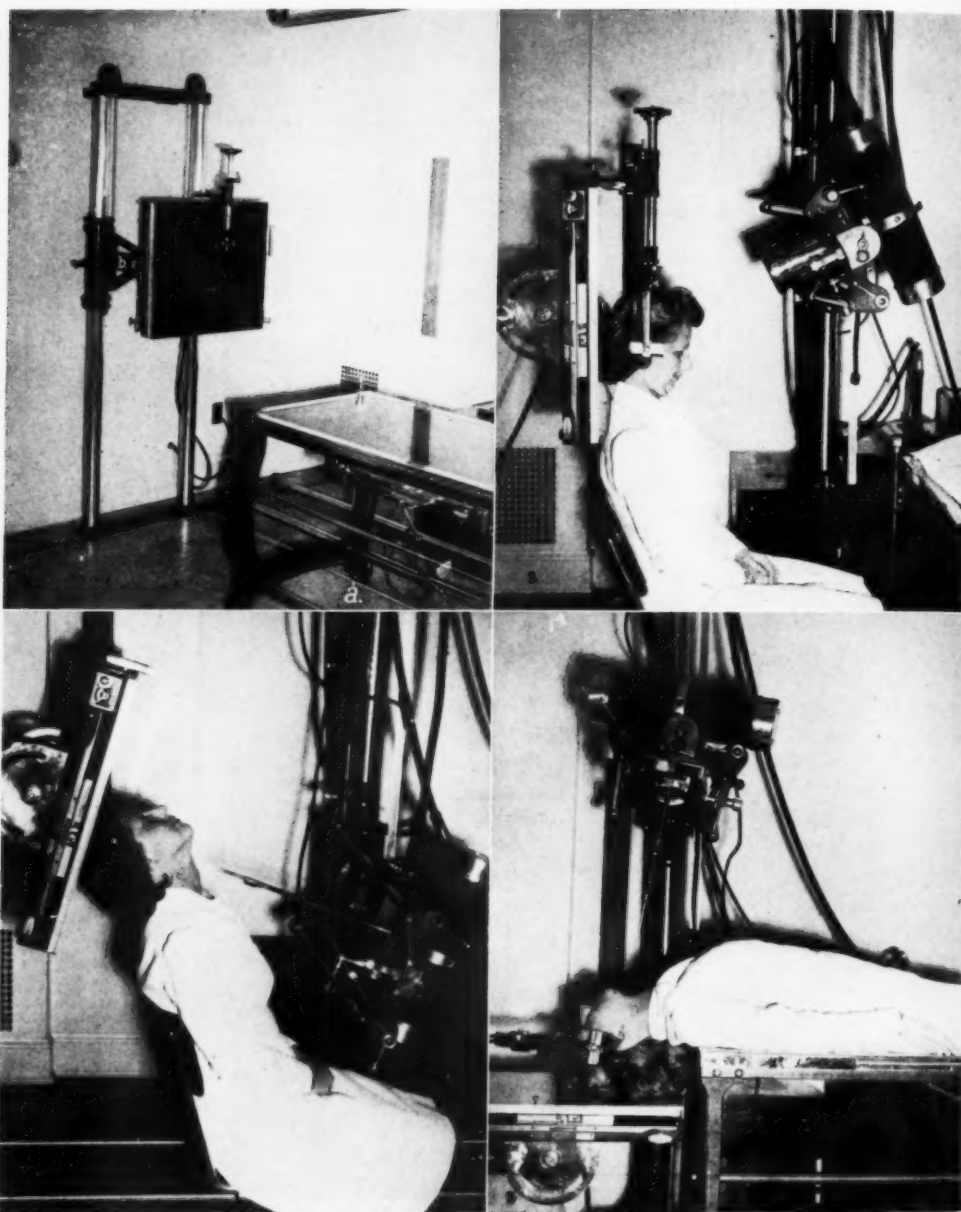


Fig. 2. The vertical head Bucky with Westinghouse head clamp in position. The upright steel chrome-plated tubes are firmly attached to the floor and wall, insuring stability and consequent elimination of unsharpness due to motion. The grooved caster on the floor track is well shown at *a* and the extension arm at *b*.

Fig. 3. Illustration showing the ease with which the Bucky can be used in making the conventional Towne projection of the skull. Exposures in this projection are often made with difficulty in the horizontal and dorsal decubitus positions, particularly in short-necked, thick-chested patients. In this instance a 25° tilt is being employed.

Fig. 4. A most satisfactory method of obtaining the Bowen-Hirtz or submentovertex projection with the vertical Bucky stand. The central beam is directed at right angles to Reed's base line and centering midway between the mental point and the prominence of the thyroid cartilage at the thyroid notch. Positioning is facilitated by the use of the erect position.

Fig. 5. The table and Bucky headstand can be used effectively in combination in order to demonstrate the base of the cranium in the supine position. A slight modification of this position can be utilized in order to profile the zygomatic arches (Henderson projection).



Fig. 6 (left). The erect Bucky may be used as a table top for radiography of extremities, as the elbow, hand or wrist. The Bucky table is easily adjusted to the various levels necessitated by the size of the patient.

Fig. 7 (right). Waters projection on sinus tunnel with 8 × 10-inch film in place. This device allows for two exposures on each film. A nasal aperture is provided for the Caldwell projection. Exposures are made through a cone with 2 1/4-inch aperture.

more easily accomplished. In lateral examinations of the cranium, more exact evaluation of lesions of the hypophyseal fossa is obtained by employing a slight tilt of the erect Bucky, angulating the Bucky face 10° from the perpendicular. This is a most useful device for obtaining true lateral films of the skull in short-necked individuals.

(b) *The temporomandibular articulations:* The technic suggested by Pendergrass (2) is used, employing a 23° angle from the horizontal plane in the lateral projection and a 35° angle with the chin depressed in the anteroposterior direction. Examination of the mandible and mastoid air cells, including the Mayer projection, as described by Danelius (3), and studies of the zygomatic arch are rendered easy.

(c) *Routine and special sinus views (as indicated above) and particularly the optic foramina:* The erect posture is found especially useful in demonstrating the optic canals. The chin is extended but slightly, in a minimal Waters projection, and the head is rotated 45° to profile the desired canal.

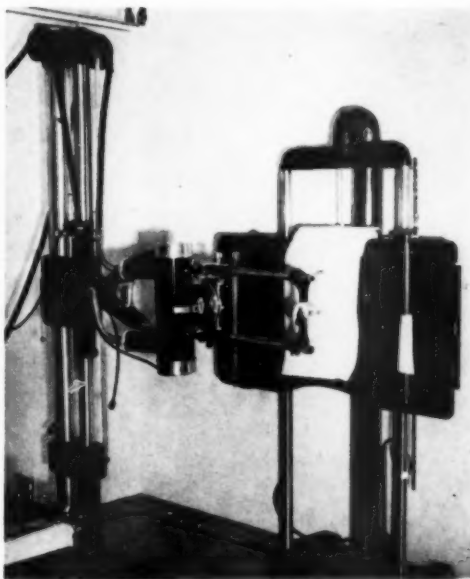


Fig. 8. Illustration showing relation of tube stand to plate changer with horizontal table moved to the opposite end of the room. With young children, however, the table often serves as a convenient platform, whereby projections can be made in the erect position. Hence, it is often advisable to move the table directly to the base of the plate changer to act as a support for the patient.

(d) *Various types of injuries*, particularly rib and shoulder lesions, which may require erect positioning in order to avoid pain; lateral transthoracic examination of the proximal humerus.

(e) *Gastro-intestinal and gallbladder examinations*, and particularly as a means of obtaining clear and brilliant lateral decubitus films of the abdomen. A recent diagnosis of chronic intussusception of the ileum was made possible by obtaining films in the above projection. In selected cases the study of sinus tracts and fistulae is facilitated.

(f) *Examination of arm, forearm, hand, wrist, and elbow*, with the Bucky face used as a table top (Fig. 6).

This equipment has been in use approximately six years and has required no special attention. No mechanical trouble of even a minor nature has developed. The accompanying illustrations show the ease and flexibility with which the device

can be used. It is difficult to describe its performance in words. It is gratifying that a number of radiologists have inspected the equipment and have commented on it with favor. The technicians working with it declare it has rendered exceptional service in all types of radiography, but particularly in the studies described above.

NOTE: Both the erect Bucky and the horizontal movable table were designed, constructed, and installed for the author by Mr. William Hogan, President of Franklin X-ray Company, Philadelphia.

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## Unsuspected Pneumoperitoneum<sup>1</sup>

CAPT. HAROLD A. COLE, M.C., A.U.S., and LT. COL. CLARENCE J. BERNE, M.C., A.U.S.

IN CASES of suspected pneumoperitoneum due to rupture of a hollow viscus, whether spontaneous or traumatic, upright films should be taken to demonstrate air beneath the diaphragm or, where the patient is too ill to sit upright, an antero-posterior projection may be made in a lateral decubitus position, in which instance the gas will collect beneath the lateral abdominal wall (Fig. 3). The percentage of patients reported as showing roentgen evidence of free gas in the peritoneal cavity following rupture of a hollow viscus varies, but the accepted average is 75-80 per cent.

In unsuspected cases where the routine scout supine abdominal view alone has been taken, Rigler has noted a valuable roentgen sign demonstrating the presence of free gas in the peritoneal cavity. This consists in the ability to visualize the inner and outer walls of the bowel. The lower density of gas within the intestine and the free extraluminal gas surrounding it will sharply delineate the outer as well as the inner wall, furnishing a sign which, as stated by Rigler, is pathognomonic of pneumoperitoneum. This sign was observed in our case when we were still unaware of Rigler's findings. The case is presented because of the comparative roentgen studies and surgical management.

### CASE REPORT

A 21-year-old American infantryman was wounded on June 15, 1944, by fragments from an exploding Japanese hand grenade thrown into his foxhole. The patient had apparently been in a crouched position with his head down and was struck by the fragments, at close range, from behind. Operation the following day, in the forward area, consisted in débridement of wounds over the buttocks, thighs, and legs, with application of casts. The patient was then evacuated to our hospital, on June 17, about fifty-four hours after being wounded.

Upon admission, the patient was dehydrated and in a state of exhaustion. His chief complaints were

of discomfort due to the wounds about the buttocks, scrotum, and lower extremities. The findings were as follows:

*Temperature:* 98.8° F.

*Head and Neck:* Negative.

*Chest:* Few shallow penetrating wounds posteriorly.

*Lungs:* Clear to percussion and auscultation.

*Heart:* No murmurs or arrhythmias.

*Abdomen:* First reported as negative.

*Back:* Numerous small penetrating wounds.

*Scrotum:* Large, dirty, draining wound on posterior surface, 2 cm. in diameter.

*Buttocks:* Covered with multiple wounds, ranging from 2 to 10 cm. in diameter, and of varying depth, with a dirty greenish discharge.

*Rectal Examination:* No abnormal findings.

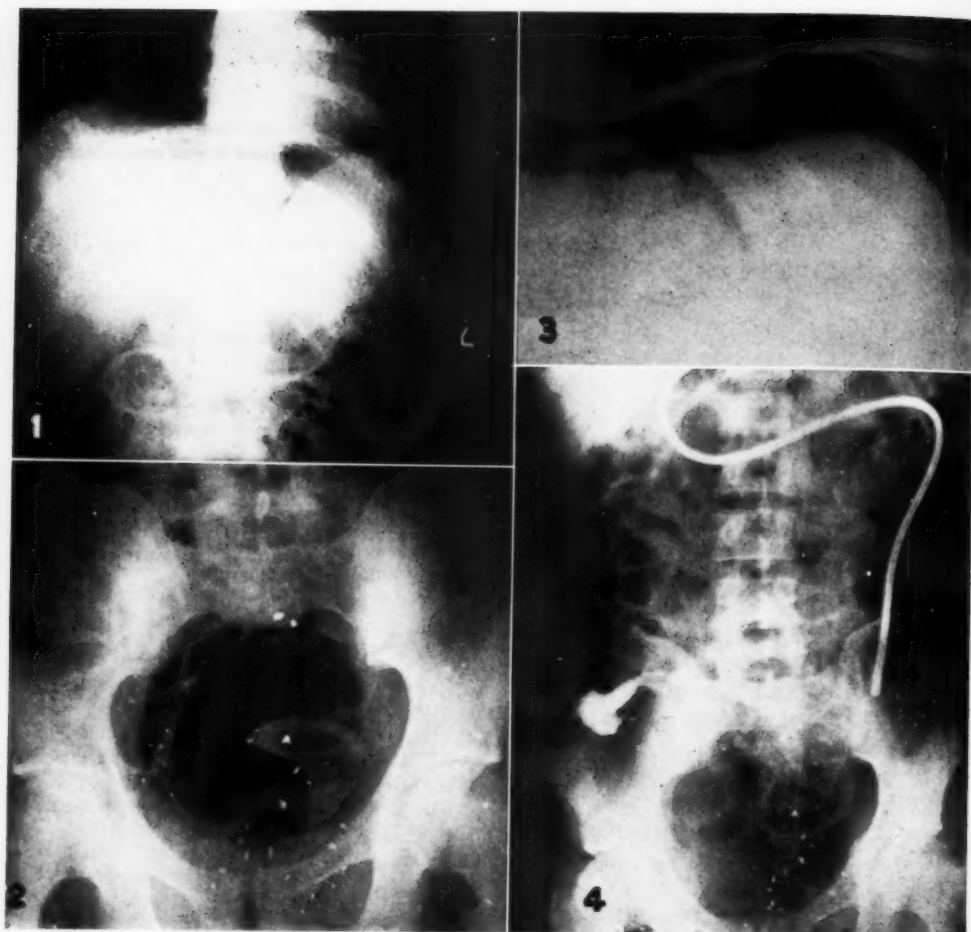
*Extremities:* Few small penetrating wounds of both arms and forearms, with two draining wounds about 1 cm. in diameter on right arm and forearm. Both thighs posteriorly were covered with multiple penetrating wounds of various sizes. There were six large, dirty, draining wounds on the lateral surface of the right thigh. The right leg showed a 2-cm. draining wound on the lateral surface of its lower third and numerous small penetrating wounds draining pus. The right foot was swollen and tender. There was a large dirty wound, 16 × 8 cm., exposing muscles and tendons, on the lateral surface; also, a dirty draining wound, 2 cm. in diameter, laterally, opposite the head of the fifth metatarsal. Another dirty 2-cm. wound was present on the plantar surface.

Immediately after admission and removal of casts the patient received a general fluoroscopic survey.

*Roentgen Findings:* The soft tissues of the feet and legs, particularly the right, were filled with small grenade fragments, typical of those from a Japanese grenade. There was a comminuted compound fracture of the right os calcis and of the proximal portion of the fifth metatarsal with the fragments displaced into the adjacent soft-tissue defect. Scattered metallic fragments were identified throughout both thighs and buttocks, a few about the back and chest, and also throughout the upper extremities. Many fragments about the pelvis seemed to lie within the true pelvic cavity, but none was identified elsewhere within the general abdominal cavity.

Because of the discomfort from the lesions over the buttocks, scrotum, and lower extremities posteriorly, the patient was fluoroscoped in a prone position. With him lying thus, a huge amount of free air was seen beneath the diaphragm, surrounding and clearly defining the liver and spleen, and displacing them caudally. Because the surgeons

<sup>1</sup> Accepted for publication in September 1945.



Figs. 1 and 2. Conventional supine views showing silhouetting effect of free air on the pelvic colon. In Fig. 1 small irregular radiolucent areas are also seen about the ascending colon.

Fig. 3. Lateral decubitus view showing effect of free air on the ascending colon.

Fig. 4. Film made one week later. The silhouetting effect on the pelvic colon and small collections of air about the ascending colon have disappeared.

were not present, an abdominal film was taken—the conventional scout supine view (Figs. 1 and 2). The paucity of findings was so distinct in contrast to the marked pneumoperitoneum demonstrated on prone fluoroscopy that a decubitus view was also taken in order to have convincing evidence for the surgeons (Fig. 3). It was presumed that the grenade fragments had perforated intestinal coils within the pelvis.

The white blood count was 15,000 with 85 per cent polymorphonuclears and 15 per cent lymphocytes. The red blood count was 2,410,000. Urinalysis was negative.

*Course:* The diagnosis of pneumoperitoneum following perforation of intestinal coils, probably colonic, having been established, it was decided to

treat the patient conservatively. He was placed on an Ochsner regime, including intubation by a Miller-Abbott tube and systemic sulfonamide therapy. Transfusions of 500 c.c. of blood were given the next two days, followed by daily administration of 250 c.c. of plasma and parenteral fluids.

The day after admission the abdomen was found to be tense, but without definite rigidity, and exquisitely tender throughout, with marked rebound tenderness. Peristalsis was absent. No masses were palpable. There was questionable dullness in the flanes.

Peristalsis was observed within forty-eight hours, but the entire abdomen remained tender, with rigidity in both lower quadrants. Three days after admission, however, the patient showed considerable

improvement. The abdomen was softer and less tender. Peristalsis was present, though faint. The course was moderately febrile, the temperature reaching 102.4° F. Part of the febrile reaction was considered to be due to the wounds in the extremities. On June 22, under pentothal anesthesia, the wounds of the right leg and foot were revised, with removal of necrotic tissue. The wound on the lateral surface of the foot was extended and considerable pus released. Hydrogen peroxide and vaseline gauze dressings were applied, and the right lower extremity was placed in a posterior molded splint. The wounds of the buttocks and scrotum were also cleansed and dressed.

On the sixth day after admission, the abdomen was soft, flat, and non-tender, and peristalsis was present. The Miller-Abbott tube was removed but was reinserted because of crampy abdominal pains and vomiting. At a later date a small amount of barium was administered through the tube. This showed an unimpeded passage, with essentially normal motility. There was progressive improvement, and on the tenth day the abdomen was normal to physical examination. The tube was clamped off, and fluids by mouth were well tolerated. There was now only a mild febrile reaction. Improvement continued, and on July 11, 1944, about three weeks after admission, the patient was evacuated. He was afebrile, eating well, and free of abdominal symptoms.

#### DISCUSSION

A case of unsuspected pneumoperitoneum following perforation of intestinal coils by grenade fragments is presented. Cure followed conservative therapy.

The initial demonstration of pneumoperitoneum was by *prone* fluoroscopy, in which instance abdominal compression had forced the gas beneath the diaphragm, producing an effect as striking as that noted in Figure 3.

The instructive feature of this case is the comparison of the silhouetting effect of the free air on the pelvic colon in the conven-

tional supine view (Fig. 2) with that on the ascending colon in the lateral decubitus view (Fig. 3). Also, if one studies the region of the ascending colon on the supine view (Fig. 1), small irregular radiolucent areas are noted lateral to the colon beneath the lateral abdominal wall, not conforming to any intestinal pattern and representing small collections of free gas delineating the outer wall of the colon. The inner wall is indistinct because of fecal material within the lumen. A film taken a week later (Fig. 4) shows disappearance of the silhouetting effect on the pelvic colon as well as of the small collections of air about the ascending portion.

#### CONCLUSIONS

Because the supine view is used routinely in making scout films of the abdomen, proper interpretation of the above radiological findings would permit the detection of such an unsuspected pneumoperitoneum. Further, in suggestive instances of silhouetting, a suspicion is provided and constitutes a basis for the taking of the classical views. Comparison of Figures 1 and 2 with Figure 3 reveals the relative magnitude of roentgen evidence of pneumoperitoneum in the supine as compared with the decubitus view.

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## Absorption of Pantopaque Following Myelography<sup>1</sup>

CAPT. WILLIAM G. PEACHER, M.C., A.U.S., and MAJ. ROBERT C. L. ROBERTSON, M.C., A.U.S.

WE HAVE PREVIOUSLY described our experiences with pantopaque, including the spinal fluid reaction and the comparative value of the medium in contrast myelography (2). Preliminary notes were given as to its absorbability in 65 of 300 cases in which spinograms were made. Observations were carried out at varying intervals following the procedure, with the following results:

No. of Cases	Absorption	Time
17	0.2 c.c.	1 mo.
10	0.4 c.c.	2 mo.
16	0.5 c.c.	3 mo.
22	0.03-1.0 c.c.	4-12 mo.

Roentgenograms of the skull were taken in 48 cases and 14 of these (29 per cent) showed small amounts of pantopaque in the basal cisterns.

Little material has appeared dealing with the absorption of pantopaque. Mayfield (1) mentioned that when a few droplets were retained, absorption took place in two to four months. In 2 additional cases in which 3 to 4 c.c. of oil remained, none was present on examination six months later. Ramsey, French, and Strain (3) gave the average estimated absorption rate as 1 c.c. in one year.

Wyatt and Spurling (4) obtained follow-up roentgenograms of 6 patients from nine to fifteen months after injection. They found absorption to be more rapid during the first few months in cases with greater oil retention. The higher rate of absorption sometimes observed was believed to be due to the nature of the contrast medium and the emulsifying action of body movement. No pantopaque was observed in films of the skull, cervical or dorsal spine. Our findings agree essentially with those of Wyatt and Spurling except for x-ray studies of the skull.

Two hundred and forty-seven follow-up studies have been made at intervals of one to twenty months after injection of panto-

paque in a series of 640 myelograms. In the beginning, studies were made of the entire subarachnoid system, including the cervical, dorsal, and lumbosacral spine and skull. Since the cervical and dorsal regions rarely showed evidence of retention, subsequent investigations were limited to the skull and lumbosacral spine. Although many cases show fixation after two to three months, this is not always true, particularly when larger amounts of the medium are retained. This has been demonstrated both fluoroscopically and in successive x-ray studies. No deleterious symptoms or signs have been noted in addition to the findings already recorded (2).

Estimates as to absorption were made by first measuring the amount of oil removed at the time of myelography. Successive anteroposterior and lateral films of the lumbosacral spine and skull were then compared to determine the size of the residual pantopaque shadow, which was stated in terms of cubic centimeters. There was a tendency toward a relative decrease in the density, as well as the size, of the residual medium over varying periods of time. All examinations were made by one observer (W.G.P.), to minimize the possibility of error. The following table shows the results, representing an average of the cases studied.

No. Cases	Absorption	Time
88	0.38 c.c.	1 mo.
37	0.52 c.c.	2 mo.
49	0.54 c.c.	3 mo.
41	0.61 c.c.	4 mo.
16	0.33 c.c.	5 mo.
16	0.36 c.c.	6 mo. +

For obvious reasons incident to military service, long-term follow-up investigations have not been possible except in isolated instances, as listed in the following table. Three cubic centimeters of pantopaque were injected in all cases with the exception of an occasional cervical spinogram, for which 6 c.c. were used.

<sup>1</sup> Accepted for publication in September 1945.

Case	Retention	Absorption	Time
1	2.0 c.c.	1.2 c.c.	20 mo.
2	0.2 c.c.	0.05 c.c.	12 mo.
3	0.1 c.c.	0.1 c.c.	13 mo.
4	0.5 c.c.	0.4 c.c.	12 mo.

Eleven cases showed complete absorption in amounts up to 0.2 c.c. over a period of twelve days to five months. Wyatt and Spurling (4) mention one case in which the contrast medium had entirely disappeared (0.5 c.c.) in eleven months. Further, in our series, 32 cases were noted with 1 to 2.6 c.c. absorption in periods of one to five months. In these patients, the greater part of the injected oil had been retained.

Extra-arachnoid injection in no way hinders absorption. Moreover, this process appears most rapid during the first three to four months after injection.

Films of the skull were available in 228 cases. Fifty-four (23.6 per cent) showed small amounts of pantopaque in the basal cisterns, most frequently in the cisterna chiasmatis, cisterna fossae lateralis cerebri, cisterna ambiens, and cisterna cerebello-medullaris. The oil was observed in the lateral and third ventricles in only 5 (2.2 per cent) instances. No signs or symptoms were present other than the single meningeal reaction in a pilot following aerobatics, previously recorded (2). Intracranial pantopaque is more likely to be found in those cases in which all the contrast medium is retained. This is not invariable, however, as one patient was seen with 0.1 c.c. remaining in the lumbar subarachnoid space after injection. Four days later, films of the skull showed the drug to be in

the cisterna chiasmatis. Successive films have revealed absorption in the cerebral as well as the spinal subarachnoid system. This process is usually slow, however, as only small amounts are present. Occasionally, also, when some pantopaque remains in the spinal canal, repeat x-rays show more within the cranium than was noted on the initial examination.

#### SUMMARY

Notes have been presented on 247 cases in which follow-up roentgen studies were made to determine absorbability of pantopaque following myelography, over varying periods of time. Films of the skull were obtained for 228 patients; 54 of these (23.6 per cent) showed small amounts of the contrast medium in the basal cisterns. Only one benign meningeal reaction occurred following intracranial progression.

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# EDITORIAL

## "Superior Pulmonary Sulcus Tumors"

In 1924, Pancoast (4) described a syndrome the outstanding features of which were an apical lung tumor, demonstrable roentgenographically, referred nerve phenomena in the upper extremity on the involved side, and cervical sympathetic paralysis suggesting a spinal cord tumor, cervical rib, or vertebral neoplasm. Four cases were included in Pancoast's original report and a pleural origin was assigned to the tumors, though he believed that a similar chain of symptoms might accompany other new growths. According to Moersch, Hinshaw, and Wilson (3) this same group of findings had been described in 1838 by Hare, in a contribution in the *London Medical Gazette*, but little attention had been paid to that early report.

In 1932, Pancoast (5) again discussed the subject, before the American Medical Association, adding four cases to his original series. He now discarded a pleural origin for these tumors and suggested that they might arise from an embryonal epithelial rest. He believed that they could not be regarded as primary lung cancers and suggested the name "superior pulmonary sulcus tumor" to designate what he regarded as a distinct pathologic entity. Symptoms included pain around the shoulder, extending down the inner side of the arm, loss of power and wasting of the muscles of the hand, and Horner's syndrome. The roentgenogram disclosed a comparatively small circumscribed shadow at the pulmonary apex, together with destruction of portions of one or more ribs and the adjacent lateral processes or bodies of one or more vertebrae.

Pancoast considered Horner's syndrome an essential feature in the diagnosis of the new tumor and did not admit to the group

apical conditions manifesting only part of the symptom complex. On the other hand, he felt that the condition might be overlooked because of incomplete roentgenographic studies, especially in cases in which pain in the shoulder was the dominant complaint.

More than two decades have passed since Pancoast's earlier report, and nearly a decade and a half since his suggestion that superior pulmonary sulcus tumors constitute a separate pathological entity. In the intervening years many observers have recorded their findings in similar cases, with a consequent clarification of the subject. Jacox (2) in 1934 reported two cases. In one of these, postmortem examination established a diagnosis of primary carcinoma of the pulmonary apex arising from the mucosa of the bronchioles in that area. In the other, no pathologic studies were made but the clinical course was similar.

In 1936, Steiner and Francis (6) recorded three cases, with postmortem confirmation in two and biopsy examination in the third. They believed that their tumors originated in the lung. Clinically they were said to represent a generally unrecognized type of cancer, but the microscopic findings corresponded to types of growth commonly observed in primary pulmonary neoplasms.

Pancoast had considered failure to metastasize a characteristic feature of the tumor, but the experience of later observers is at variance with his opinion. In a case reported by Frost and Wolpaw (1), which proved histologically to be a sympathoblastoma of the superior mediastinum, there was secondary involvement of the upper lobe of the right lung, the esophagus, adjacent vertebral bodies, and ribs. The primary lesion in this case was believed to

L arise from the inferior cervical sympathetic ganglion. Steiner and Francis also found metastases in two of their three patients, in one to distant osseous structures and in one to the regional lymph nodes and kidney.

Moersch, Hinshaw, and Wilson in 1940 reviewed the cases seen at the Mayo Clinic in a ten-year period. They encountered thirteen examples in which all the essential features were present and four additional cases in which Horner's syndrome was absent. From these observations they were led to believe that Horner's syndrome may not be present until late in the course of the disease, that it may be a manifestation of the degree of spread of the apical tumor, and not related to a specific neoplastic type. In nine of their cases distant metastases were demonstrable.

The prognosis in apical lung tumors has been almost uniformly bad. All of Pancoast's original patients received radiotherapy, but experienced little or no benefit. In his second report he stated that these tumors resisted all efforts at irradiation, while surgical removal was obviously impossible and was usually rapidly followed by a fatal termination. In one of the cases reported by Jacox, temporary relief from pain, lasting several months, followed administration of deep x-ray therapy. The pain recurred, however, and chordotomy was required for its control. Two of the cases reported by Steiner and Francis received deep x-ray therapy with little relief

of symptoms and no regression of the tumors. Moersch, Hinshaw, and Wilson reported that the great majority of their patients were dead within six months of initial examination.

Great credit is due Pancoast for the recognition of these tumors and the elaboration of the symptom-complex which accompanies them. It is unfortunate that in no instance did he have the benefit of postmortem examination. Autopsies in many of the cases reported later, by other authorities, disclosed primary tumors of the lung and indicated that metastasis was of frequent occurrence. It seems apparent that any tumor in the pulmonary apex which involves the cervical sympathetic nerves may produce this clinical syndrome.

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## RADIOLOGICAL SOCIETIES OF NORTH AMERICA

*Editor's Note.*—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

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*Sociedad de Radiología y Fisioterapia de Cuba.*—Offices in Hospital Mercedes, Havana. Meets monthly.

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## ROENTGEN DIAGNOSIS

### THE HEAD AND NECK

**Contrast Roentgenography of the Pneumatic Cells of the Temporal Bone.** Max Unger. *Am. J. Roentgenol.* 54:384-388, October 1945.

With conventional roentgenography, the extent and character of pneumatization of the mastoid process can be determined only partially. In order to obtain more preoperative information, the author has devised a method for the introduction of an aqueous solution of a radiopaque salt into the pneumatic cells. It can be used only where there is a perforated tympanic membrane, a mastoid fistula, or both. It requires a careful washing out of the cells by saline solution, with the aid of a pneumatic otoscope and gravity, since the presence of pus, swollen mucous membrane, and polyps will interfere with the results. The entire procedure takes about thirty to forty minutes, but the author believes the information obtained from the subsequent roentgenograms makes the effort worth while.

L. W. PAUL, M.D.

**Endolumbar Pneumoencephalography, Simplified (A Note on Its Advantages).** Joseph H. Globus and John L. Simon. *J. Nerv. & Ment. Dis.* 102: 412-415, October 1945.

In the simplified method of endolumbar pneumoencephalography described in this paper, the air is introduced with the patient lying in his bed, the head of which is raised on shock blocks. The authors have found that this simplified procedure is more comfortable for the patient, easier for the examiner, and equally if not more satisfactory from the point of view of results. Two illustrative pneumoencephalograms are included.

SYDNEY F. THOMAS, M.D.

**Measurement of Relative Exophthalmos by Roentgenography.** Benjamin Friedman. *U. S. Nav. M. Bull.* 45: 482-487, September 1945.

The author describes a method for measuring relative exophthalmos with x-rays. He uses special contact lenses equipped with a central lead dot. These lenses are placed over the eyes while the patient is lying supine on the x-ray table. A pair of obstetrical calipers supported by blocks is used to maintain the head in the correct position so that the mid-sagittal plane is exactly perpendicular to the center line of the table. As a further aid in positioning, a pair of small uprights is placed on opposite sides of the table with a string drawn tightly between them over which one may sight to line up the patient exactly. The distance from the tip of the chin to the table top is measured and recorded so that, when the examination is repeated, the position of the patient can be duplicated exactly. The central ray of the tube is directed from the foot end of the table at a 35-degree angle through the orbits to the film placed at a level above the patient's head.

On the finished radiograph, the lead dot overlying the exophthalmic eye will be projected at a higher level than that over the normal eye. It may also be displaced laterally or medially. Because of the amount of distortion, the measured displacement represents a magnification of four to one, so that a 2-mm. displacement in comparison to the opposite eye represents

about 0.5 mm. of exophthalmos. This method therefore is quite precise. It does not measure the exact amount of exophthalmos, but it does give the relative degree.

The diagrams included with the article are far more explanatory than any verbal description of the method.

BERNARD S. KALAVJIAN, M.D.

**Entrapment of Barium Paste in the Piriform Sinuses. A Sign of Paralysis of the Glossopharyngeal Nerve.** P. Marqués. *J. de radiol. et d'électrol.* 26: 47-48, 1944-45.

Paralysis of the glossopharyngeal nerve, which is rarely seen by itself, is manifested by the following triad of symptoms: non-painful dysphagia, displacement toward the affected side of the posterior wall of the pharynx during attacks of nausea, disturbance of taste localized to the base of the tongue. A distinctive radiologic sign described by Calvet, and known by his name, consists in entrapment of barium in the piriform sinus.

In a normal subject, at the moment of swallowing, the contraction of the superior constrictors of the pharynx, and, more especially, the shortening of the pharynx and the ascent of the larynx due to the pharyngopalatinus and the stylopharyngeus muscles, accelerate the bolus on its way to the esophagus. In paralysis of the glossopharyngeal nerve, this movement is absent, or is faulty, and one sees the barium pouring over the base of the tongue, arrested in part at the valleculae, then pocketed in the piriform sinus. If the paralysis is confined to one side, the sign is correspondingly unilateral; if paralysis is bilateral, the sign is bilateral. The author adds that the sign is not positive in pseudobulbar paralysis, but is an early manifestation in a true bulbar paralysis.

PERCY J. DELANO, M.D.

### THE CHEST

**Evaluation of the Comparative Efficiency of Various Methods of Mass Radiography.** Charles F. Behrens, Herman E. Hilleboe, Harold F. A. Long, and J. Yerushalmy. *U. S. Nav. M. Bull.* 45: 635-646, October 1945.

This article goes into the variable factors in conducting a survey, bringing out the methods of handling a comparative study with special reference to: (1) "inter-individual" variations in reading the standard; (2) "inter-individual" variations for each of the techniques under investigation—as 35-mm., 70-mm., and 4 × 5-inch stereoscopic celluloid films and 14 × 17-inch paper films, compared with 14 × 17-inch celluloid film as a control; (3) "intra-individual" variations in reading the standard; (4) individual scores for each technique for each reader; (5) "inter-individual" variations of the scores of different readers.

"It is apparent from the foregoing," say the authors, "that the definitive analysis involved in a comparative study of various techniques of mass radiography includes many difficult and elaborate operations." [The whole problem is obviously self-limited by the skills of the so-called "readers"; in other words, the value of a survey is only as good as the individual men conducting it; reducing it to a statistical study is difficult at best, and

not possible or practical in most surveys, but useful for investigation purposes only—S. F. T.]

SYDNEY F. THOMAS, M.D.

**Röntgenological Aspects of Therapeutic Pneumoperitoneum in Pulmonary Tuberculosis.** Ernst A. Schmidt. *Am. J. Roentgenol.* 54: 375-383, October 1945.

A review of the history, rationale, technic, indications, contraindications, sequelae, and complications of pneumoperitoneum therapy in pulmonary tuberculosis is given. The author reports his observations on the roentgen aspects of this method in 61 cases and 6 representative examples are described with illustrative roentgenograms. The effects of pneumoperitoneum which can be observed roentgenologically are: (1) elevation of the diaphragm, which may reach 10 cm. or more, combined with a corresponding limitation of diaphragmatic mobility; (2) diminution of lung volume (which may amount to 15 to 35 per cent reduction in chest capacity) combined with compression of cavities, "crowding" of the bronchovascular markings, and corresponding changes in the appearance of tuberculous lesions as well as of the heart and mediastinum; (3) separation of the subphrenic viscera, especially the stomach, liver, and spleen, from the diaphragm; (4) disappearance of intra-abdominal adhesions. Of complications, ascites is the most frequent roentgenologic finding.

L. W. PAUL, M.D.

**Classification of Non-Tuberculous Chest Diseases with Special Reference to So-Called Atypical Pneumonia.** Charles Rich. *Canad. M. A. J.* 53: 265-274, September 1945.

"The term atypical pneumonia, unless qualified, would be better discarded," states the author. It is not an entity but covers a group of several diseases. These, as well as all non-tuberculous chest diseases, have six underlying principles:

1. Weakening of the bronchial tree by repeated exposures and infections.
2. Vulnerability due to four structural faults: (a) drainage against gravity; (b) response of the wall of the bronchial tree by swelling and secreting, thus adding to the stasis; (c) dependence on the ciliated membrane, which is the first to be destroyed by secondary infection; (d) rigid sinus walls in which compression occurs when the ostia are closed off by inflammatory swelling.
3. Irreversibility of damage in a certain number of cases. For example, the ciliated membrane may be damaged and not completely restored. Subsequent attacks hit the same weakened area and are more prolonged. Normally non-pathogenic secondary bacteria may carry on the process. This irreversibility explains prolongation, recurrences, and chronicity.
4. Continuity. (a) Continuity of Type: Each cold or "flu" may relight the same damaged area. (b) Continuity in Time: Continuous discharges occur after the "cold" has damaged the tissues. (c) Continuity of Structure: The infection may spread between portions of the tract, e.g., sinusitis leading to a bronchitis. (d) Familial Continuity: If the patient has asthma or hay-fever look for a familial history of allergy.
5. Acquired allergy due to chronic infections.
6. Barriers: The author states that healthy lungs will not be attacked by moderate infections unless the

barriers above have been irreversibly damaged by previous infections or altered by allergy. Severe infections may possibly overwhelm the barriers and produce disease, but these are the true lobar pneumonias.

Using the above principles as a basis, the author presents the following classification:

#### *Acute Lung Diseases*

1. Lobar pneumonia.
2. Pneumococcal pneumonia, atypical (or abortive).
3. Bronchopneumonia
  - (a) Respiratory allergy.
  - (b) Respiratory damage
  - (c) Lung damage.
4. Virus pneumonia:
  - (a) Possible.
  - (b) Proved.

#### *Chronic Lung Diseases*

1. Respiratory allergy and hypersensitivity.
  - (a) Upper: Vasomotor rhinitis or perennial hay-fever, nasal polyposis.
  - (b) Lower: Vasomotor or allergic bronchitis and asthmatic bronchitis.
2. Respiratory damage.
  - (a) Upper: Sinusitis, recurrent or chronic.
  - (b) Lower: Bronchitis, recurrent or chronic.
3. Lung damage.
  - (a) Silent.
  - (b) Lung damage bronchitis.
  - (c) Bronchiectasis.

STANLEY H. MACHT, M.D.

**Loeffler's Syndrome (Transient Pulmonary Infiltrations with Eosinophilia). Report of a Case and a Review of the Available Literature.** H. I. Spector. *Dis. of Chest* 11: 380-391, September-October 1945.

In 1932, Löffler described a syndrome characterized by a mild group of symptoms: low-grade fever, some cough with expectoration, some fatigue, occasionally a metallic taste to the sputum, and not infrequently a mild pain in the chest; a paucity of physical signs; a blood eosinophilia varying from 10 to 60 per cent, and spontaneous healing within two to three weeks. Serial roentgen examinations of the chest reveal transient pulmonary infiltrations, unilateral or bilateral. The course is usually benign, and the condition is often discovered accidentally or during routine examination.

The etiology is unknown. Tuberculosis has been excluded. The parasitic theory is plausible, since numerous cases have been reported, mainly in children, in which a blood eosinophilia and transient pulmonary infiltrations were accompanied by intestinal parasites. The allergic theory must also receive consideration, since allergic symptoms have on some occasions led to the discovery of the condition. The seasonal incidence and epidemic form suggest an infectious agent, perhaps an atypical virus. Such an infection would account for the pulmonary infiltration, and its absorption might elicit an eosinophilia.

Some authors regard the lung lesions as due to emboli, infarcts, localized bronchial asthma, or atelectasis. They have also been attributed to a localizing allergic edema, and the name allergic pulmonary edema has been proposed for the disease. Von Meyenburg (*Virchows Arch. f. path. Anat.* 309: 258, 1942) maintained that the transient infiltrations represent an eosinophilic pneumonia; his findings are based on material from four accidental deaths.

In the author's case there was an unquestionable allergic background. HENRY K. TAYLOR, M.D.

**Eosinophilic Lung (Tropical Eosinophilia).** Philip J. Hodes and Francis C. Wood. *Am. J. M. Sc.* 210: 288-295, September 1945.

Eosinophilic lung is characterized by fever, cough, asthma, bronchopulmonary changes demonstrable on the roentgen film, and eosinophilia. The disease, common in India, has been known to develop in Europeans, and may involve American troops returning from the Orient.

Nothing definite is known concerning the etiology of this disease. Weingarten (*Lancet* 1: 103, 1943) has never seen a case in a person who has always lived in a dry climate. All of his patients lived near the sea. The asthmatic manifestations and the eosinophilia suggest an allergic factor. There is no seasonal incidence, nor do race, age, diet, alcohol, or social status seem significant.

The disease commonly begins with lassitude, anorexia and slight fever, which may rise to  $101^{\circ}$  in the evening. During the second week, a dry hacking cough, which is worse at night, usually develops. The cough becomes more severe as time goes on. Many of the patients have symptoms of asthmatic bronchitis. Indeed, the disease may start with an asthmatic attack. The patients who suffer nocturnal distress frequently are comfortable during the day. After several weeks the fever subsides, weakness gradually disappears, and there is no further loss in weight. The bronchopulmonary symptoms usually persist and become chronic if treatment is not instituted.

Physical examination reveals slight hyperresonance and sibilant and sonorous as well as occasional crepitant râles. During the febrile period, the spleen is moderately enlarged in one-half of the cases. The most striking feature is the massive eosinophilia, which may constitute as much as 92 per cent of a high white cell count.

Roentgenograms made at the end of the second week show bilateral pulmonary mottling, consisting of lesions which vary from 2 to 5 mm. in diameter and have a dense center and an ill-defined blurred periphery. These are not pathognomonic. This stage rarely lasts more than four weeks. Thereafter the lesions regress, leaving only prominent hilar and truncal markings. One may see clinical findings without roentgen findings, or roentgen findings without clinical signs. The disease may be related to Löfller's pneumonia.

Treatment is by intravenous neoarsphenamine every fourth day for six injections.

Two cases are described in detail.

BENJAMIN COPLEMAN, M.D.

**Contribution to the Study of Intrathoracic Metastases in Cancer of the Pharynx.** Guy Morin. *J. de radiol. et d'électrol.* 26: 117-124, 1944-45.

This study is based upon a series of 1,334 patients with primary neoplasms of the pharynx (hypopharynx, rhinopharynx, and oropharynx) treated at the Curie Foundation, by Coutard and Baclesse, between 1920 and 1938. Pathologically, the tumors were of two types, epitheliomas and lymphosarcomas, the epitheliomas outnumbering the lymphosarcomas almost 10 to 1. Of the entire series 43, or 3.2 per cent, metas-

tized to the thorax (including the lung parenchyma, pleura, and mediastinum). The incidence of thoracic metastases for each of the tumor types was approximately the same: 3.1 per cent for the epitheliomas and 3.7 per cent for the lymphosarcomas. Local extension, at least to some degree, occurred in all cases, and in all except 2 (both epitheliomas) there was lymph-node involvement. As to whether the route of dissemination was by the blood stream or the lymphatics, the author wisely offers only conjecture in each case.

The average interval between the discovery of metastases and death averaged eight and a half months. The physical signs and symptoms appearing with the metastases are discussed, and the radiologic manifestations are described and illustrated by reproductions of films. A frequent form was the multiple nodular type familiar in many metastatic processes, for which the French have a very descriptive term, *lâcher de ballons*. Large single metastatic lesions are also shown, circular or oval in form, which in the anteroposterior view might well suggest a primary growth, even a benign tumor, as a teratoma, or one well walled off, as a neuroblastoma. Pleural effusions, miliary lymphogenous dissemination, and hilar node clusters are frequently evident.

Among other points, the author emphasizes the frequency of clinically latent metastases demonstrable roentgenographically and the fact that metastasis may occur following apparent cure of the primary neoplasm.

PERCY J. DELANO, M.D.

**Tumour-Simulating Intrathoracic Heterotopia of Bone Marrow.** Erik Ask-Upmark. *Acta radiol.* 26: 425-440, Aug. 31, 1945. (In English.)

Massive deposits of heterotopic bone marrow simulating tumor growth have been observed occasionally in the retroperitoneal space, in some few instances in the thoracic cavity, and once within the cranial cavity. The author reports a case of intrathoracic localization. His patient was a 70-year-old female with a history of anemia for thirty-six years and epigastric pain and increasing jaundice for seven years. The patient presented the picture of hemolytic jaundice, with an enlarged spleen and a somewhat hyperplastic bone marrow. Roentgenographic examination of the chest revealed an elliptical shadow  $4.5 \times 7$  cm. just to the right of the seventh, eighth, and ninth thoracic vertebrae. There was no apparent involvement of the vertebrae or ribs. The skull and pelvic bones showed areas of decreased density. The remaining skeletal examination was negative. Because of the history of hemolytic jaundice, the mass was considered to represent heterotopic bone marrow. The diagnosis, made four years before the death of the patient, is said to be the first to be established antemortem.

At necropsy the spleen was found to be considerably enlarged, and the malpighian corpuscles were difficult to identify. In the thoracic cavity were two large paravertebral masses closely adherent to the vertebral column. These were soft, with a rather even surface, and bluish-red in color. Microscopically, this tissue was similar to hyperactive bone marrow.

Eight cases from the literature with similar post-mortem findings are reviewed. The author concludes that in the presence of hemolytic jaundice with an intrathoracic paravertebral tumor, the possibility of heterotopic bone marrow should be considered.

J. H. WEISS, M.D.

**Atrial Septal Defect. Studies of Hemodynamics by the Technique of Right Heart Catheterization.** Emmett S. Brannon, H. Stephen Weens, and James V. Warren. *Am. J. M. Sc.* 210: 480-491, October 1945.

In normal subjects, the oxygen content of the right atrial blood has been found, by means of right heart catheterization, to be somewhere between that of the superior and inferior vena cava, since the atrial blood is a mixture of the blood from these two vessels. In cases of atrial septal defect, the oxygen content of the right atrial blood is higher than that of the venae cavae, confirming a left-right shunt.

By means of the catheter, blood samples for analysis were obtained from the right atrium, the inferior and superior vena cava, and, in one case in which the catheter slipped through the interatrial septal defect, from the left atrium. The position of the opaque catheter was always checked by means of fluoroscopy. Arterial blood was obtained from the femoral artery. Direct blood pressure readings were made, oxygen consumption was determined, and the cardiac output calculated. Up to the time of the report the authors had performed 420 catheterizations without untoward incident.

Of 4 adults with atrial septal defects, one denied symptoms referable to the cardiovascular system; all had signs of cardiac enlargement. Three had symptoms of congestive failure on admission. In all a murmur was heard along the left border of the sternum from the 2nd to the 5th intercostal space. In all, the pulmonic second sound was accentuated. All showed evidence of right axis deviation on electrocardiographic tracings.

The common, but not characteristic, roentgenologic features were marked dilatation and increased pulsation of the pulmonary artery, shortening of the aortic knob, and enlargement of the right heart chambers. The heart in atrial septal defect is usually larger than in patent ductus arteriosus, but the differentiation depends largely on the history and the physical signs. The size of the heart in each of the cases which are presented by the authors decreased with treatment of congestive failure. The interatrial shunt is only occasionally demonstrated angiographically, and then with difficulty and not unequivocally. The technic of right heart catheterization has permitted the exclusion of the diagnosis of atrial septal defect in cases showing hypertrophy of the right ventricle and prominence of the pulmonary artery due to other causes.

In 4 patients in whom there was clinical evidence of atrial septal defect, the average oxygen content of the right atrial blood was higher than that in the superior or inferior vena cava. Although the intra-atrial pressures on the two sides of the heart do not differ greatly, the right is pumping at least twice as much as the left.

A satisfactory explanation for the left-right shunt has not been offered. It has been suggested that this may occur because of the relative cephalad position of the left atrium as compared with the right. There was no change in the oxygen concentration in the atrial blood when the patient was studied in the head-down position.

In one patient evidence indicated that a difficulty in oxygenating blood rather than the shunt was producing symptoms. It has been noted previously that sclerotic changes and thrombosis of the pulmonary vessels may complicate an atrial septal defect.

BENJAMIN COLEMAN, M.D.

**Calcification in the Ductus Arteriosus.** Arthur E. Childe and Eleanor R. Mackenzie. *Am. J. Roentgenol.* 54: 370-374, October 1945.

Postmortem examination of a nine-month-old infant revealed a calcified area within the remnants of the ductus arteriosus sufficiently extensive to be readily demonstrated in a roentgenogram of the specimen. No chest films had been made prior to death. Since this occurrence, the authors have studied 3 other cases in which roentgen examination of the chests of living infants have shown calcified shadows corresponding in position to the ductus arteriosus. The calcified shadows have been small, linear or crescentic in shape, and have required roentgenograms with sharp detail for their visualization. In only one case could the shadow be observed on roentgenoscopy and then it was seen to pulsate with the heart and vascular shadows. In none of the cases was there any evidence of cardiovascular abnormality. The condition does not appear to have any clinical significance but needs to be differentiated from tuberculous calcifications. Calcification has not been observed by the authors in any of their 18 cases of patent ductus arteriosus which have been operated upon.

L. W. PAUL, M.D.

## THE DIGESTIVE SYSTEM

**Abnormal Esophageal Communications: Their Types, Diagnosis, and Therapy.** Osler A. Abbott. *J. Thoracic Surg.* 14: 382-392, October 1945.

In this discussion of abnormal esophageal communications, only acquired fistulas are included. Their causes in order of importance are carcinoma, inflammatory diseases, and trauma. Syphilis, tuberculosis, and empyema of the pleural cavity are the commonest inflammatory lesions. The most usual site for the fistula is from the esophagus into the trachea or bronchi. Other routes are to the skin, pleural cavity, and pericardial cavity and mediastinum.

The literature is reviewed and 23 additional cases are reported, in 6 of which the fistula was successfully closed. There have been 15 successfully treated cases reported by others.

The occurrence of paroxysms of coughing on eating, particularly on taking fluids, is the most dramatic and suggestive symptom. The diagnostic measure of greatest value is x-ray demonstration of the fistula, preferably with iodized oil rather than barium, to prevent irritation of the lung. Injection of methylene blue followed by bronchoscopy or demonstration of the dye elsewhere is also a valuable procedure.

The fundamentals of therapy are maintenance of nutrition and good drainage. Although this is a serious condition, it should not be looked upon as hopeless.

HAROLD O. PETERSON, M.D.

**Cardio-Esophageal Relaxation.** Morris Berk. *Gastroenterology* 5: 290-298, October 1945.

Cardio-esophageal relaxation, or insufficiency of the cardia, is an abnormality of unknown etiology in which the gastric contents regurgitate passively into the esophagus through a patulous cardiac sphincter. The chief symptoms are epigastric distress and a lumpy sensation at the lower sternum. In the majority of cases insufficiency of the cardia is associated with other diseases in or outside of the gastro-intestinal tract. Its chief importance lies in the fact that it

may be confused with other conditions about the terminal esophagus, as hiatus hernia, diverticulum, achalasia, cancer, etc.; it is probably frequently overlooked by the roentgenologist. Cardio-esophageal relaxation can usually be diagnosed by fluoroscopy; with the patient in the supine or Trendelenburg position, barium may be seen to flow passively into a dilated lower esophagus and gravitate back into the stomach when the upright position is assumed. Any procedure which increases intra-abdominal pressure will aid in demonstrating the flow of barium through the incompetent sphincter.

A case of cardio-esophageal relaxation in which the roentgen diagnosis was confirmed by esophagoscopy is presented. Regurgitation and the relationship between position and the development of symptoms were outstanding in this case.

**Lymphosarcoma of the Stomach.** Leonard Cardon and Regina S. Greenebaum. *Am. J. Digest. Dis.* 12: 339-344, October 1945.

The diagnosis of lymphosarcoma of the stomach is difficult to make for the following reasons. "(1) The disease is rare. (2) It mimics carcinoma or ulcer completely in the majority of cases. (3) The differential features seldom appear. (4) Some of these differential features occur also in atypical carcinoma, gastritis, syphilis and other diseases of the stomach. (5) The suggestive features may not occur until late in the disease."

Because of the possible efficacy of x-ray treatment in this type of lesion, an attempt has been made to establish diagnostic criteria by study of a proved case. The patient was a woman aged 54, who began having attacks of epigastric pain in 1930. X-ray examination of the stomach showed no lesion. Cholecystograms revealed a non-functioning gallbladder, but the patient refused operation. The attacks persisted, and in 1931 another roentgenogram showed a filling defect on the lesser curvature side of the pylorus, leading to a diagnosis of carcinoma. Operation was again refused, and three months later (February 1932) the defect was no longer demonstrable. In October 1934, an x-ray examination again showed the defect, but surgery was deferred because of an unexplained high fever. On Nov. 18, 1934, the patient entered the hospital complaining of constant pain radiating from both axillae to the epigastrium, pain in the back, weakness, vomiting, and vertigo. X-ray examination at that time showed an inoperable "carcinoma" of the stomach.

"The outstanding features of the case were: fever, a mass in the abdomen resembling Riedel's lobe, a spleen whose tip was just palpable at the costal margin, tenderness over an indistinct mass in the epigastrium, an irregular, poorly filled stomach with carcinoma-like termination of the defect at the pylorus, achlorhydria, occult blood in the stool, and non-visualization of the gallbladder."

Death followed an exploratory laparotomy. At autopsy a primary reticulum-cell sarcoma of the stomach was found.

It is the opinion of the authors that such symptoms as the four-year duration of the disease without cachexia, the prolonged septic fever, the splenomegaly, and the late appearance of occult blood in the stool, should singly or in combination lead to the suspicion of a lymphoblastoma of the stomach.

JOSEPH T. DANZER, M.D.

**Gastro-Duodenal Ulcer in Childhood.** Erik Wamberg. *Acta paediat.* 33: 86-97, Oct. 31, 1945. (In English.)

Ulcerations of the stomach and duodenum in children are most frequently encountered in the first year of life and around puberty. In infants, the ulcers nearly always are associated with infections, intoxications, trauma, circulatory disorders, or cachexia, but in children above five years of age the vast majority of ulcers are based on actual gastroduodenitis. The condition may manifest itself by (a) a gastroduodenal syndrome, as in adults, (b) the sudden occurrence of complications (hemorrhage or perforation), or finally and presumably most often by (c) vague and uncharacteristic symptoms.

Two cases of duodenal ulcer in girls, aged nine and eleven, are reported. The younger girl gave a history of periodic vomiting for five years; the other had suffered from vomiting for two years, with periodic pain in the epigastric region and two attacks of severe melena. In each patient, x-ray examination revealed a typical duodenal ulcer.

The author emphasizes that gastroduodenal ulcers occur more frequently in children than is generally supposed and urges x-ray examination in the presence of uncharacteristic dyspeptic symptoms.

**Case of Ileocolic Intussusception Reduced Without Operation.** Børge Faber. *Acta radiol.* 26: 409-414, Aug. 31, 1945. (In English.)

The author reports a case of ileocecal intussusception reduced by conservative methods. A short review of the literature is given and Hellmer (*Acta radiol.* 24: 235, 1943) is quoted as presenting the only similar case on record. Faber's patient was a twenty-one-month-old boy in apparently good health until six hours before he was seen. He became suddenly ill, with intermittent attacks of vomiting and violent crying. Roentgen examination by contrast enema showed an obstruction in the region of the hepatic flexure, giving the typical radiographic appearance of intussusception. This was reduced with no difficulty, but filling of the small bowel showed a persistent picture of intussusception about 10 cm. long. After four attempts with manipulation and pressure, the intussusception was released and apparently did not reform. The author claims that this case shows that some types of small bowel intussusception can be reduced conservatively.

J. H. WEISS, M.D.

**Chronic Ulcerative Colitis with Infantilism and Carcinoma of the Colon.** William E. Ricketts, Earl P. Benditt, and Walter Lincoln Palmer. *Gastroenterology* 5: 272-280, October 1945.

A case of infantilism and carcinoma of the colon in an eighteen-year-old boy who had had chronic ulcerative colitis since the age of two and a half is reported. The patient was 51 inches tall, weighed 45 pounds at death, and was underdeveloped sexually and somatically, appearing four or five years younger than his actual age. There was roentgen evidence of retarded ossification and generalized osteoporosis. Histologic examination showed the testis and epididymis to be infantile in type. The adenocarcinoma of the descending colon is interpreted as the consequence of the ulcerative colitis. Other cases of infantilism in association with ulcerative colitis are cited.

**Multiple Cancer of the Colon.** Olle Olsson. *Acta radiol.* 26: 415-424, Aug. 31, 1945. (In German.)

The author reports five cases of multiple cancer of the colon. The difficulties encountered in the roentgenological diagnosis are discussed in detail, and it is conceded that a final decision as to true tumor multiplicity is frequently impossible. As a practical conclusion it is demanded that neither the radiologist nor the surgeon content himself with partial colon exploration but, in each individual case, look for and exclude multiple tumor occurrence.

ERNST A. SCHMIDT, M.D.

**Hernia of the Ileum Through a Hole in the Transverse Mesocolon. Report of a Case with Symptoms and Radiological Appearances Simulating a Meckel's Diverticulum.** Rodney Smith. *Brit. J. Surg.* 33: 187-188, October 1945.

A man aged 30 gave a history of four attacks of abdominal pain and vomiting over a period of eight months following operation for an umbilical abscess. Each attack had consisted in typical small intestinal colic occurring intermittently over a period of several days, accompanied by severe vomiting, abdominal distention, anorexia, and general malaise. Physical examination was essentially negative. The history, however, suggested some form of intermittent obstruction of the lower small intestine. Radiological study following a barium meal revealed a normal stomach and duodenum. At the end of two and a half hours the meal was in the ileum and ascending colon. At this time a sausage-shaped segment of small intestine was observed extending medially from the region of the hepatic flexure. At the end of five hours the segment of small intestine was still filled, while the large intestine was well outlined and distinct from it. Subsequent examination showed the segment completely emptied of barium. A diagnosis was made of Meckel's diverticulum, with the segment of intestine bearing it fixed in an abnormally high position in the abdomen by inflammatory adhesions from the previous abscess. Operation, however, revealed no evidence of bands or adhesions but showed a circular hole in the transverse mesocolon about 1 inch from the hepatic flexure. Through this a loop of the terminal ileum had herniated. The defect was corrected and the patient made an uneventful recovery.

MAX CLIMAN, M.D.

**Radiographic Diagnosis of Hernia into the Lesser Peritoneal Sac Through the Foramen of Winslow: Report of a Case.** M. S. Hollenberg. *Surgery* 18: 498-502, October 1945.

The author reports what is apparently the first instance of preoperative diagnosis of hernia into the lesser peritoneal sac through the foramen of Winslow. The patient was a 76-year-old white male complaining of acute epigastric pain. He had enjoyed good health until the year before, when he began to suffer recurrent attacks of diarrhea. His acute illness began eight hours before he was seen by the author. The pain was localized in the upper part of the abdomen, with severe attacks of colic lasting about two minutes and gradually subsiding. The clinical picture was that of an acute obstruction. No peristaltic waves were visible during the colicky attacks. There was acute tenderness over the epigastric region upon palpation. There had been no vomiting, and no flatus or feces had been passed

since the onset of the illness. Epigastric resonance was marked on deep percussion and there was some fullness in the epigastrium.

Following a barium meal, two parallel crescentic outlines were demonstrated on the lesser curvature, with the stomach hugging a rounded gas-filled mass. This picture suggested to the author the possibility of a hernia into the lesser peritoneal cavity. A barium enema confirmed this impression, outlining the rectosigmoid and the descending and left half of the transverse colon, where the barium shadow abruptly ceased. The large, round, gas-filled mass hugged by the stomach was still visible, as was gas-distended bowel leaving this mass, apparently being pinched off in the region of the foramen of Winslow.

Operation revealed a large tympanic mass, over which the gastro-hepatic omentum could be moved freely. No cecum or ascending colon could be found. The tip of the appendix was located high on the right side under the liver. The right half of the transverse colon was absent. After opening the lesser omentum and deflating the cecum, the herniated bowel was easily reduced through the foramen of Winslow.

The patient died two weeks after operation from pulmonary embolism. At autopsy there was no fluid in the abdominal cavity and the foramen of Winslow was large, admitting three fingers. Numerous adhesions of the gallbladder and liver to the center of the transverse colon were present, and the right lobe of the liver was elongated and constricted, conditions which were probably responsible for the unusual hernia.

J. E. WHITELEATHER, M.D.

**Congenital Eventration of the Diaphragm. Surgical Management.** J. Dewey Bisgard and George E. Robertson. *Am. J. Surg.* 70: 95-99, October 1945.

This is a case report of eventration of the right dome of the diaphragm in an infant, cured by operation. It is recorded because no such case was found to have been reported previously and it is suspected that some deaths among the newborn are really due to unrecognized congenital eventration of the diaphragm, which, as in this case, have a prospect of surgical cure.

Eventration is defined as an abnormally high leaf of the diaphragm as a result of paralysis, aplasia, or atrophy of the muscle fibers but with no break in continuity of the dome, a feature which serves for differentiation from diaphragmatic hernia. Eventration has been observed in patients of all ages. Most reported cases, however, are in adults, so that the authors believe the lesion may in many instances be acquired. The condition may be asymptomatic. Symptoms, when present, are of four general groups—gastric, cardiac, pulmonary, and pleuropulmonary.

Eventration is most common in the left dome of the diaphragm. Not infrequently there may be associated maldevelopments of lung, heart, or liver, failure of intestinal rotation, or unassociated congenital deformities, such as cleft palate.

The authors' patient had cyanosis and dyspnea which developed ten days following an apparently normal delivery. Feeding difficulties ensued and the child failed to gain weight. On physical examination, the right side of the chest was found to move more than the left and there was lateral retraction with inspiration. Dullness to percussion and absence of breath sounds were present below the level of the right second

rib anteriorly and in the upper two thirds of the left chest. Roentgenograms of the chest showed the right dome of the diaphragm to be elevated to the fourth rib posteriorly. There was increased density of the right lung, probably from compression, and an enlarged heart shadow displaced to the left, in contact with the left costal border. The liver shadow was displaced upward and its lower border was above the costal margin.

A diagnosis of either eventration or hernia was made and exploration was undertaken *via* an intrathoracic approach. The right dome of the diaphragm was found to be intact, its apex extending to the second rib anteriorly. Its excursion, although negligible, was not paradoxical and it consisted obviously of muscle. By plication, the dome of the diaphragm was shortened and brought down to the level of the tenth rib. The postoperative course was not unusual. There was complete relief of dyspnea and cyanosis, and seven months later respirations were normal and both lungs were completely aerated. Indeed, the infant appeared to be quite healthy, though the right dome of the diaphragm was still one interspace higher than the left.

The authors believe that this case was probably more amenable to surgery than some because the diaphragm contained muscle and substance in which sutures would be retained against tension. R. E. BOOTH, M.D.

**Dynamics of Biliary Drainage: Its Relation to Cholangitis and Pancreatitis from Stricture of the Ampulla of Vater.** John M. McGowan. *Surgery* 18: 470-478, October 1945.

The poor results following biliary surgery can be explained on two bases: an incorrect preoperative diagnosis and failure on the part of the surgeon to pay proper attention to the physiology of the biliary and pancreatic systems following removal of the diseased gallbladder. The postoperative care of the patient who has undergone a cholecystectomy begins in the operating room. When the common bile duct has been opened for any of the generally accepted indications, a T tube should be inserted for prolonged drainage. Besides its therapeutic effect this procedure makes possible postoperative studies of the biliary and pancreatic systems.

T-tube studies are usually begun two weeks after operation and consist in pressure determinations and roentgenologic examination. The method of intrabiliary pressure determinations has been described elsewhere (McGowan *et al.*: *J. A. M. A.* 106: 2227, 1936. *Abst. in Radiology* 28: 380, 1937). Excessive pressure (over 30 mm. of water) may be due to spasm, stricture, edema, pancreatitis, or stones. In the case of spasm, the pressure is promptly reduced by amyl nitrite inhalation. Cholangiographic studies will determine whether or not there is obstruction from pancreatitis, stones, or stricture.

When the common bile duct is perfused with saline solution at increasing pressures, there comes a point when the patient experiences a sense of discomfort. This point, which is referred to as the "perfusion pain level," is frequently around 70 mm. of water three weeks after operation. With continued T-tube drainage, the bile duct becomes more resistant to pressure, so that after two or three months it will tolerate pressures of as high as 500 to 700 mm. of water before pain is produced. If the T tube is removed while the pain level is still low, one may expect continued pain. If,

on the other hand, the pain level is as high as 500 mm. of water, postcholecystectomy pain is not to be expected, since the secretion pressure of the liver is only 300 mm.

To determine the amount of pressure at which duodenal spasm will occur, the patient is given 1/6 grain of morphine. This procedure is also an index of the possibility of postcholecystectomy pain. If the pressure produced by the morphine spasm is low, the patient should not suffer from biliary dyskinesia; if, however, it is as high as 300 mm., attacks of pain may be expected.

For roentgen study of the biliary tract, diodrast may be injected through the T tube into the common duct. The relation between the biliary tract and duodenum may be studied at the same time by injecting barium into the duodenum through an indwelling duodenal tube. A series of three films are usually taken, one with the patient in the resting state, one following injection of morphine by ten minutes, and a third following deep inhalation of amyl nitrite by one minute.

In view of his observations in several hundred cases, the author concludes that the T tube should not be removed until the resting intrabiliary pressure is 30 mm. or less of water, the perfusion pain level is 500 mm. or more, and roentgen studies of the common duct show absence of obstruction to the flow of bile into the duodenum. Two weeks following operation, the T tube should be clamped at increasing intervals, starting with half an hour twice daily and increasing by one hour per day. When the tube is being clamped off twenty-four hours of the day, one should wait another three weeks with a symptom-free patient before the tube is removed.

A case is recorded, with reproductions of combined cholangiograms and duodenograms made following cholecystectomy and exploration of the common duct. In this case stricture of the ampulla of Vater is believed to have produced a regurgitation of bile into the pancreatic duct and pancreatitis. Pancreatitis then produced obstruction to the common bile duct and gallbladder resulting in cholangitis and cholecystitis. The immediate postoperative course was favorable, but ten days after continuous clamping of the T tube there was a recurrence of pain, with chills and fever. The tube was reopened and the symptoms were relieved. Spasm of the duodenum was considered of no significance in this case since the common bile duct and pancreatic duct entered the duodenal wall through separate tunnels opening into the ampulla of Vater inside the duodenum. Incidentally, the patient lived in a malaria region, and periodic attacks of chills and fever preceding operation were attributed, probably incorrectly, to malaria. J. E. WHITELEATHER, M.D.

### THE SPLEEN

**Calcified Cyst of the Spleen: Report of a Case, with Review of the Literature.** Edwin M. Jameson and Orland F. Smith. *U. S. Nav. M. Bull.* 45: 537-541, September 1945.

Cysts of the spleen of any type are rare and calcified cysts are extremely rare. This report presents a case of the latter type observed in a naval hospital, in which the diagnosis was made radiologically. The author quotes Snode (*Am. J. M. Sc.* 206: 726, 1943. *Abst. in Radiology* 43: 95, 1944) as stating that any large annular calcification in the left upper abdominal quadrant

is usually either a calcified splenic cyst or an aneurysm of the splenic artery. Bruit should be heard over an aneurysm.

Usually symptoms are negligible. In the case reported, there was a complaint of dragging sensation and epigastric fullness. No palpable mass could be made out and no unusual sounds were heard over the spleen. Other findings were also essentially negative. Splenectomy, following the radiologic diagnosis, completely relieved the patient. Pathologically, the spleen was moderately enlarged, with a large oval cystic mass in the upper pole. Microscopically, the wall of the cyst was made up of dense fibrous tissue with extensive calcification. In some areas, there was flat epithelial lining; in other areas, this was absent.

BERNARD S. KALAYJIAN, M.D.

### THE MUSCULOSKELETAL SYSTEM

**Differential Diagnosis of Tuberculosis in Joints of the Extremities.** Raymond W. Lewis. *Am. J. Roentgenol.* 54: 329-337, October 1945.

The early work of Pheemister with regard to the differential diagnosis of tuberculous and pyogenic infections of the joints is reviewed and its value confirmed. In tuberculous arthritis there is preservation of the joint space for months or years, since the cartilages, though dead, are still present to hold the bones apart. The earliest bone destruction is not on the contiguous opposing bony surfaces but about the margins of the weight-bearing surfaces. There is evidence of muscle atrophy about the joint with little tendency to repair and ankylosis. In acute suppurative arthritis there are rapid and severe osteoporosis about the joint, early destruction of cartilage, resulting in decrease in joint width, bone destruction first on the weight-bearing portions of the articular surfaces, and little, if any, atrophy of muscles. In the hips the above-mentioned criteria of tuberculosis are seldom observed, possibly because the early manifestations cannot be depicted properly in this joint. Caries sicca also offers diagnostic difficulties, and the diagnosis is made largely by exclusion. Diseases of the joints other than suppurative arthritis usually offer no difficulty in differentiation from tuberculosis. It may, however, be closely simulated by rare instances of joint involvement in leukemia, histoplasmosis, etc.

L. W. PAUL, M.D.

**X-Ray Examination of the Hip-Joint in Tuberculous Disease with Special Reference to the Localisation of Cavities and Tuberculous Foci.** Franklin G. Wood and M. C. Wilkinson. *Brit. J. Radiol.* 18: 332-334, October 1945.

Serial radiographs are as essential in the treatment of tuberculosis of the hip as they are in tuberculosis of the lungs. The different phases of the disease can be demonstrated more accurately by roentgenography than by clinical methods, and, indeed, the degree of calcification and re-ossification occurring in the healing stage can be determined only by radiographic study. Lateral views of the hip are particularly useful but frequently are not taken. The most informative lateral view is made with the patient lying on the affected side so that the lateral aspect of the thigh is in contact with the table, the other leg being drawn backward and the pelvis rotated so as to form an angle of 65 degrees with the horizontal. Thus the head, neck, and shaft of the

femur are in the true lateral position. Tomography is also of value.

SYDNEY J. HAWLEY, M.D.

**Penicillin Treatment of Acute Haematogenous Osteomyelitis.** I. W. J. McAdam. *Brit. J. Surg.* 33: 167-172, October 1945.

A series of 40 cases of osteomyelitis treated by penicillin is discussed from two standpoints: (1) saving of life by overcoming the initial septicemia or pyemia; (2) cutting short of local infection and limiting of bone necrosis. A daily dose of 100,000 units of penicillin was used, introduced intramuscularly in 29 cases and through an intramedullary needle in 11 cases.

There are two well defined clinical types of osteomyelitis and the response to penicillin supports this classification. The first group includes patients with evidence of septicemia in addition to a local lesion of bone; the second group comprises those with a local lesion only. In this series 21 patients had a generalized infection; of these, 10 had metastatic foci and 20 had positive blood cultures. The clinical response in this group was not dramatic. The blood cultures became sterile, on an average, in three days, whereas the temperature remained raised for seven to fourteen days, finally subsiding by lysis. The second clinical type is represented by 19 patients with varying degrees of toxemia in whom the general condition was good, the blood cultures were negative, and there were no metastatic lesions. In this group, the temperature usually subsided within seven days of the institution of treatment, and general improvement was obvious before that time.

Conservative measures following control of the general infection were favored in this series; only 5 out of 32 patients with acute infections of long bones had operative treatment. Aspiration of a subperiosteal abscess alone was done in 2 of the cases treated conservatively, and in 15 cases a sternal puncture needle was inserted into the affected metaphysis for relief of intramedullary tension. Sequestrectomy was found to be unnecessary and exacerbations did not occur in any of the patients treated by aspiration and immobilization. The results of more extensive operative treatment were not encouraging. Two patients developed sequestra which required removal and had discharging sinuses after eleven and seven months, respectively. In 10 of the 40 patients, septic arthritis occurred. This is believed to be most effectively treated by aspiration of pus and local injection of penicillin into the joint cavity every second day. Aspiration of a relatively inaccessible joint is, however, not always practicable and systemic treatment has to be relied upon. There is evidence that penicillin in detectable amounts will pass from the blood stream through a synovial membrane when the joint is infected.

The outstanding radiological features in early infection are extensive decalcification, limited amount of subperiosteal bone formation, and absorption of small sequestra. Decalcification in most of the author's cases was widespread. Excessive periosteal new bone formation did not occur, nor was there wide separation of the periosteum from the cortex, presumably because bone destruction and pus formation were controlled by penicillin. Healing was demonstrated by irregular recalcification. The absence of massive sequestra facilitated early healing and the absorption of smaller sequestra resulted in localized areas of sclerosis. The limited periosteal bone formation maintained a moderately regular outline of the bone with little deformity.

In this series of 40 patients treated with penicillin there was only one death, despite the fact that 19 of these patients had a staphylococcal septicemia, 9 had metastatic bone lesions, and 10 had septic arthritis. An excellent table is appended, giving details of treatment of the entire series.

MAX CLIMAN, M.D.

**Brodie's Abscess: Two Case Reports.** James W. Downey and Harold E. Simon. *Am. J. Surg.* 70: 86-94, October 1945.

Brodie's abscess is a well localized chronic or sub-acute, non-specific pyogenic abscess, usually involving the juxta-epiphyseal regions of long bones. It is often entirely overlooked or wrongly diagnosed. Prompt response to treatment makes early diagnosis essential.

Two cases are presented. In one the abscess was in the trochanteric area of the left femur; in the other in the lower end of the right radius. The characteristic symptoms are pain and bony enlargement, which may be present weeks to years before the underlying lesion is recognized. The pain is worse with activity or atmospheric changes and is usually more severe at night. Effusion into the adjacent joint is not infrequently observed. Examination reveals a fusiform swelling, and localized tenderness is frequently elicited. The soft tissues are characteristically not involved, and the spontaneous development of a draining sinus is rare. Shortening of the extremity may occur rarely in the young; more rarely, lengthening is observed. Early diagnosis depends upon the roentgen demonstration of a small area of decreased density, with slight thickening of the surrounding bone, usually near the epiphysis of a long bone. Later the cavity becomes clear-cut and the circumference of the bone is increased. The differential diagnosis must take into consideration sarcoma, chronic sclerosing osteitis, bone cysts, tuberculosis, and syphilitic osteitis and periostitis.

Brodie's abscess occurs predominantly in males during the age of greatest physical activity, suggesting trauma as a contributing factor. The significance of trauma, however, is questionable. The upper and lower ends of the tibia are the sites most frequently involved; next in order are the femur, humerus, and radius. The frequency of acute infections preceding Brodie's abscess is striking, the identical organism being recovered from the abscess in many instances. Typhoid, paratyphoid, *B. coli*, streptococcus, and staphylococcus infections are specifically mentioned.

The present methods of treatment consist of complete excision of the cavity with saucerization and primary closure. Sulfonamides locally, frequently supplemented by systemic administration pre- and post-operatively, are indicated. A cast is usually applied for two or three weeks after operation. The prognosis is excellent.

C. R. PERRYMAN, M.D.

**Fibrous Dysplasia—A "Cystic" Lesion of Bone.** Herbert M. Stauffer and Patrick J. Fitzgerald. *U. S. Nav. M. Bull.* 45: 653-660, October 1945.

The authors report a case under Jaffe and Lichtenstein's designation "fibrous dysplasia" (see *Arch. Path.* 33: 777, 1942. *Abst. in Radiology* 40: 319, 1943).

A 20-year-old Army veteran had a dull aching pain in the right hip of six months' duration and a slight limp. The physical findings were otherwise insignificant, and laboratory tests were not remarkable. The blood serum calcium was 11.7 mg. per cent and the

serum phosphorus 3.1 per cent. Roentgen examination of the hip disclosed evidence of an expansile, bone-destructive lesion involving the intertrochanteric portion of the femur and the base of the femoral neck. There was localized thinning of the cortex, the periphery of which was still intact. In addition, there was a mottled, somewhat circular shadow of increased density in the central portion of the cyst-like area. Other skeletal studies showed no abnormalities. Biopsy was done, and photomicrographs show the replacement of normal bone by loosely arranged fibrous connective tissue with numerous spicules of newly formed non-lamellated, atypically calcified metaplastic fiber bone. The cyst was curetted and filled with bone chips from the tibia, and the patient made a good recovery.

The authors give a brief but comprehensive review of the literature, mentioning "Albright's triad" of (1) bone changes of "osteitis fibrosa," (2) cutaneous pigmentation, and (3) endocrine dysfunction, with precocious puberty in females. Neither pigmentation nor endocrine disturbance was present in the case reported here.

Differentiation of fibrous dysplasia from hyperthyroidism is based on the relatively normal calcium metabolism and the histologic examination. The latter also serves for differentiation from skeletal enchondromatosis (Ollier's disease), xanthomatous bone lesions, Paget's disease, multiple myeloma, and localized lesions such as unicameral bone cyst, giant-cell tumor, chronic osteomyelitis, enchondroma, eosinophilic granuloma, and other rarefying lesions.

There are two practical conclusions to be drawn from this paper. (1) After biopsy to discover the true nature of the disease, the lesion should be curetted out and autogenous bone chips be put in place to prevent further growth with an eventual pathologic fracture. (2) The term "cyst" as applied to these lesions is not justified even though radiographically they appear cystic. They are not true cysts but are composed of fibrous tissue with atypical bone formation and are correctly designated "fibrous dysplasia."

SYDNEY F. THOMAS, M.D.

**On Osteoarthritis Alkaptonurica (Ochronotica) with Description of One Case.** Johan Hertzberg. *Acta radiol.* 26: 484-490, Aug. 31, 1945. (In English.)

The clinical importance of alkaptonuria with ochronosis is mainly due to the lesions it produces in the bones and joints. These were first described by Virchow in 1866. The ochronotic pigment is deposited in the articular cartilages, especially those with poor metabolism. These become black, lose their elasticity, and become brittle. Fragments of the blackened cartilage are broken off into the joint and deposited in the synovial membrane, with subsequent thickening of the membrane and finally of the entire articular capsule. In spite of some regeneration, constant wear may eventually destroy the cartilage completely. When this occurs, there are changes in the articular surface of the bone, with sclerosis and bone proliferation and subsequently bony ankylosis.

The case recorded is that of a 54-year-old man who two years prior to admission began having pain in the left shoulder, with stiffness. One year later he experienced the same symptoms in the right shoulder. More recently, pain and swelling had developed in the knees. Physical examination revealed atrophy of the

muscles of both shoulders, with ability to elevate the arms only to the horizontal. This movement was performed only by moving the scapula. Complete ankylosis was present in each shoulder joint. There was some swelling of the right knee, with limitation of motion. The urine exhibited typical ochronosis. Roentgenography showed extensive deforming osteoarthritis, with ankylosis in both shoulders. Osteoporosis and narrowing of the joint space were seen in both knees. The spine showed osteoporosis with loss of the normal lumbar lordosis. The intervertebral disks were narrowed and in some places partially absent. There was also calcification in many of the disks, and calcification of the lumbar vertebral ligaments was observed.

This case shows findings similar to those previously reported in osteoarthritis alkaptonurica. While the roentgen picture is fairly characteristic, the final diagnosis rests on the clinical symptoms and urinary findings.

J. H. WEISS, M.D.

**Osteochondritis Dissecans of Carpal Scaphoid. Report of a Case.** Paul E. McMaster and Ralph T. Levin. U. S. Nav. M. Bull. 45: 742-744, October 1945. This is a report of a case of osteochondritis dissecans of the carpal scaphoid, diagnosed on the basis of the history and physical and roentgen findings.

**Polymorphous-Cell Sarcoma, the Malignant Phase of Giant-Follicle Lymphoma, with Generalized Skeletal Involvement and Multiple Pathological Fractures. Report of a Case.** William E. Kenney. J. Bone & Joint Surg. 27: 668-673, October 1945.

The disease entity known as giant-follicle lymphoma is characterized by splenomegaly and generalized lymphadenopathy. The lymph follicles show hyperplasia, which is characteristic of the disease. Malignant transformation may occur.

The present case report deals with a 77-year-old female with multiple pathological fractures on whom biopsy of a lymph node showed giant follicle hyperplasia. At autopsy the intestinal lymph nodes, the pancreas, skull, and almost all the other bones were found to be involved by a neoplastic process, presenting at different sites microscopic features resembling giant-lymph-follicle hyperplasia, Hodgkin's disease, reticulum-cell sarcoma, and polymorphous-cell sarcoma. The spleen and liver were not invaded.

JOHN B. MCANENY, M.D.

**Internal Derangements of the Knee Joint. Diagnostic Scope of Soft Tissue Roentgen Examinations and the Vacuum Technique Demonstration of the Menisci.** J. Gershon-Cohen. Am. J. Roentgenol. 54: 338-347, October 1945.

Adequate study of the knee joint requires a demonstration of the soft tissues as well as the bones comprising the joint. Special techniques for soft-tissue examination are not necessary if a proper light source is used in viewing the roentgenograms. The internal meniscus may be demonstrated by traction or abduction of the leg. An anteroposterior view is made with the patient lying on the affected side, with the leg extended and a sand bag under the knee, and with forcible abduction of the leg against the table top during the exposure. In normal subjects, the internal meniscus can be demonstrated in not more than 80 per cent of examinations;

the external meniscus in not more than 20 per cent. The only positive finding of value is failure of visualization of the menisci in the affected knee when they can be demonstrated on the healthy side. This usually indicates synovial effusion. A search should then be made for fractures at the attachment of the meniscus and evidences of swelling of the tibial collateral ligament, since sprain of this ligament usually occurs with internal meniscus injuries. Other conditions which can be demonstrated by roentgen examination, and which might be confused with internal derangements clinically, are discussed, including loose bodies, sprain or rupture of the tibial collateral ligament, periarticular bursitis, cysts of the menisci, and neoplasms.

L. W. PAUL, M.D.

**Derangements of the Knee Joint. Diagnostic Aid Obtained by the Roentgenologic Examination of the Soft Structures and of the Menisci Without Injection of Contrast Media.** J. Gershon-Cohen. U. S. Nav. M. Bull. 45: 488-499, September 1945.

This paper begins with an extensive review of the symptomatology, physical findings, and morphology of various types of injuries to the knee joint involving the cartilages and ligaments and includes a description of a vacuum technic for demonstration of the menisci (see preceding abstract). The author feels that at least three projections of the knee are desirable; the anteroposterior, the lateral, and the longitudinal. The last named is particularly suitable for a study of the patella.

**Intra-Articular Osteochondral Fractures as a Cause for Internal Derangement of the Knee in Adolescents.** Paul H. Harmon. J. Bone & Joint Surg. 27: 703-705, October 1945.

Osteochondral fractures in the knee are believed to be frequently overlooked or discovered only after arthrotomy has been performed under a mistaken diagnosis of meniscus injury. Actually, such fractures are rather common in juveniles and adolescents following injury to the knee, particularly the patella. There is a loose body in the joint, and the patient complains of pain, swelling, and possibly locking of the joint.

Two cases are recorded here. The first patient was a 15-year-old boy who lacerated his knee in a fall. X-ray examination demonstrated a small fragment of bone in the articular space. This body was removed and found to be about three times the expected size, due to the cartilaginous covering. The fragment had been detached from the lateral femoral condyle.

The other patient was a 16-year-old girl who dislocated the patella in a fall, with resulting hemarthrosis, pain, and disability. Roentgen examination failed to demonstrate any fracture or loose body. The joint was opened five months after injury, demonstrating a definite defect in the articular surface of the patella on the medial aspect, in the process of filling-in with fibrocartilage. The loose body was found in the joint cavity and was much larger than the defect in the patella, showing that about half the latter had been filled in during the interval following the injury.

The films of the second case were reviewed after operation, and a rather indefinite soft shadow was seen in the joint cavity. The possibility of soft-tissue x-ray studies being of help in these cases is suggested.

JOHN B. MCANENY, M.D.

**Aseptic Necrosis of the Astragalus Following Arthrodesing Procedures of the Tarsus.** Frederick M. Marek and Albert J. Schein. *J. Bone & Joint Surg.* 27: 587-594 October 1945.

The blood supply of the astragalus is derived chiefly from the anterior tibial artery. Authorities differ on minor details, but there is quite common agreement that the nutrient vessels enter the bone at the neck, a rather "precarious" location. It is not surprising, therefore, that procedures involving extensive resection of the head and neck of the astragalus for the correction of foot deformities should be followed by aseptic necrosis. Mention of this complication seems, however, to be lacking in the literature, though its occurrence after fractures and fracture dislocations is well known.

The authors have encountered aseptic necrosis of the astragalus 5 times in a series of 61 cases in which wide resection of the head and neck was done. Lesser degrees of increased density and temporary mottling of the body were observed in other cases, but these changes did not persist and did not necessitate limitation of weight-bearing. The 5 case histories are presented, and roentgenograms illustrating their course are reproduced. An additional case in which necrosis developed following fracture is included for comparison.

The conclusion is reached that where extensive resection is necessary for the correction of foot deformities, it would seem advisable to remove bone from the scaphoid or cuneiform rather than from the astragalus. In any event, postoperative roentgenograms should be watched for evidence of aseptic necrosis. Should it occur, weight-bearing must be avoided for six to nine months in order to prevent collapse of the bone and eventual development of a secondary osteoarthritis of the ankle joint.

JOHN B. MCANENY, M.D.

**Metatarsal March (Fatigue) Fractures.** Albert L. Leveton. *Am. J. Surg.* 70: 49-57, October 1945.

The author reports 259 cases of march fracture of the metatarsals which constituted 2.35 per cent of the orthopedic cases seen at a station hospital during a period of nine months. He considers it to be an occupational disease associated with military training and extremely rare in civilian life.

Primary importance is attached to fatigue of the peroneus longus and tibialis posticus muscles. The tendons of these muscles form a sling which assists in the support of the long plantar arch. None of the fractures occurred in association with marked degrees of pes planus and only 14 in pes planus of second degree. The atavistic foot is not believed to play an important predisposing role in these fractures, although in only 64 of the cases was there conformity to the "normal" foot, in which the five metatarsal bones are arranged in parallel formation with the head of the first metatarsal on the same transverse plane or even a little more distal than that of the second. If the second metatarsal was longer and protruded beyond the other segments, it was apt to be the site of fracture, but this did not hold true in fractures of the third metatarsal. The author does not believe that age or pre-induction occupation are contributing factors since the age distribution of his cases coincided with that of the station population in general; 53 per cent had followed a sedentary occupation, 47 per cent an active occupation. Most fractures occurred during the second to fourth month of training, when the program was most strenuous.

The right foot was involved 154 times and the left 105 times. The fractures occurred in the second and third metatarsals 228 times. Twenty-three cases of multiple fractures were found and in 10 of these the fractures were bilateral. The second and third metatarsals again were most frequently involved. The fracture was complete in 199 cases and incomplete in 60 cases. In 35 there was some displacement.

The onset of clinical symptoms usually followed a long or forced march and was acute or insidious. The patient was usually able to continue with his march, and the average interval between the onset of symptoms and hospitalization was 15.4 days. Pain and swelling of the dorsum of the foot were the usual complaints. Physical examination showed point tenderness and some swelling over the involved metatarsal. Motion of the toe caused pain.

The roentgen findings vary with the age of the injury, and a negative roentgenogram is not conclusive in the presence of positive clinical findings. In such cases the author advises a recheck in about a week. Early in the first week there may be merely periosteal elevation and thickening. Following the first week there may be diffuse thickening of the periosteum or more commonly the fracture extends through the entire thickness of the bone. Large, fluffy, or cottony callus at the fracture site is one of the characteristics of metatarsal march fracture, but there is slight production of callus in fractures involving the neck. When fracture involves the first metatarsal, it occurs at the base and is of the "ice-crack" type. After four to six weeks the callus becomes organized and a fusiform swelling is present at the fracture site. Angulation is not common.

The patients are kept at bed rest for three weeks, although no untoward effects were observed in a small group who were permitted to bear weight on the heel after seven to ten days. They are then placed on a reconditioning program for two to four weeks, and are eventually returned to full duty. In none of the cases was the foot immobilized in plaster. Ninety-nine per cent of the patients made a good recovery. A few continued to complain of pain, attributable to mental factors or to excessive callus. Non-union was not observed and delayed union was extremely rare. None of the patients was discharged from the Army because of disability attributable solely to march fracture of the metatarsal.

FRANK P. BROOKS, M.D.

**Post-Traumatic Para-Articular Calcifications and Ossifications of the Ankle.** Arnold D. Piatt. *Am. J. Roentgenol.* 54: 348-354, October 1945.

The subject of post-traumatic calcification and ossification in the soft tissues about joints is discussed in general and a case of para-articular calcification occurring at the ankle joint is described in detail. Roentgenograms made shortly after a twisting injury to the ankle revealed only evidence of joint effusion. Because of pain and disability, the patient, a 22-year-old soldier, was hospitalized for nine days. On return to full duty, discomfort in the ankle continued. Roentgen examination about six weeks after the injury revealed a linear film-like calcification between the tibia and fibula, apparently in the interosseous membrane. A crescent-shaped calcification along the posterior malleolus of the tibia could be seen, and this was not attached to the bone. Physiotherapy was begun, with improvement in

symptoms, and a later roentgenogram revealed little change.

This type of lesion is best treated conservatively, with immobilization and physiotherapy. Partial disability is likely to be prolonged, and full function is not regained. The calcifications persist and undergo maturity or fusion. Spontaneous regression is said to occur, but it was not observed in any of the author's cases.

L. W. PAUL, M.D.

**A Case of Deformity of the Thorax, Probably Due to Congenital Malformation of the Dorsal Spine.** Risto Elo. *Acta radiol.* 26: 456-462, Aug. 31, 1945. (In German.)

The author describes the case of a 13-year-old girl with a severe deformity of the dorsal spine and one side of the thorax. The x-ray examination revealed extensive developmental defects and lack of fusion in the 4th to 8th thoracic vertebrae, resulting in kyphoscoliosis and costal abnormalities. The bone structure and the density of the affected vertebrae were normal, and there were no signs of inflammatory or malignant change.

ERNST A. SCHMIDT, M.D.

**Unilateral Hypoplasia of Lumbosacral Articular Processes. A Case Report.** Paul E. McMaster. *J. Bone & Joint Surg.* 27: 683-686, October 1945.

This case report deals with a 30-year-old man with pain in the lower back and right lower extremity. Physical findings indicated changes in the right hip and thigh, with measurable atrophy of the right gluteal, thigh, and calf muscles. Roentgen examination of the lumbosacral area showed the right side normal, but on the left the articular process between the fifth lumbar and the first sacral segments were markedly underdeveloped. The left lamina of the fifth lumbar vertebra was also hypoplastic. There was moderate haziness of both sacroiliac joints, indicating arthritic changes.

This report is believed to be the first to describe this particular change, although anatomical variations and anomalies are known to occur frequently in this region. Radiographically, the changes are not well demonstrated in the anteroposterior and lateral views but are clearly seen in oblique views of the lumbosacral region.

JOHN B. McANENY, M.D.

**Sagittal Cleft (Butterfly) Vertebra.** Frederick J. Fischer and R. E. VanDemark. *J. Bone & Joint Surg.* 27: 695-698, October 1945.

This is a report of two cases of moderate developmental abnormality of a vertebral body. One patient showed mid-line separation of two unequal portions of the third lumbar body, with the larger and higher portion on the right and the smaller and shallower portion on the left, resulting in a left lumbar scoliosis. The second patient showed a division of the body of the seventh thoracic vertebra by a narrow cleft without lateral displacement of the divided parts or anterior wedging of the body. The eighth thoracic body, however, of which the anterior third was lacking, showed marked anterior wedging resulting in a definite kyphosis at this level.

The typical butterfly appearance is demonstrable in the anteroposterior view. The adjacent intervertebral spaces may be narrowed but not collapsed.

JOHN B. McANENY, M.D.

**Congenital Humeroradial Synostosis.** H. S. Murphy and C. G. Hanson. *J. Bone & Joint Surg.* 27: 712-713, October 1945.

A case of bilateral humeroradial synostosis in a newborn infant is recorded. Though an hereditary tendency has been observed in other cases of this deformity, no history of its occurrence in the past three generations was obtained in the present case. References to the rather scanty literature are appended.

**Congenital Absence of the Odontoid Process. A Case Report.** Raymond C. Scannell. *J. Bone & Joint Surg.* 27: 714-715, October 1945.

Roentgen examination of a 23-year-old soldier who had sustained an injury of the neck in wrestling revealed complete absence of the odontoid process, with abnormal mobility of the atlas on the axis in flexion and extension. The previously reported cases of this anomaly, to which references are given, came under observation because of dislocation of the atlas on the axis.

**Radiologic Approaches Necessary in the Treatment of Congenital Subluxations of the Hip, from the Surgeon's Point of View.** A. Laquerrière. *J. de radiol. et d'électrol.* 26: 48-51, 1944-45.

This paper is a résumé of one by Barcat published in 1943 in the *Revue d'orthopédie*. It discusses the radiologic diagnosis of congenital subluxation of the hip at three periods: before the child begins to walk; between the ages of eighteen months and eight years; and in older children.

Walking may be delayed as much as ten months after the usual time. In the youngest group three roentgen signs are of importance: (1) an exaggerated obliquity of the roof of the acetabulum (the angle with the horizon exceeding 35 degrees); (2) absence, or at least diminution in size, of the capital epiphysis, which normally appears between the sixth and twelfth months, usually about the eighth; (3) displacement outwards and upwards of the upper end of the femur, the so-called "lobster-claw" sign.

In children from a year and a half to eight years old, films of both hips are indispensable, as incipient and minimal luxations may otherwise escape notice. The clinical and radiologic signs which may occur at this age are enumerated. Arthrography following injection of a contrast medium may be useful. It is less essential in the eight- to fifteen-year-old group.

The paper is illustrated by roentgenograms. Some might take issue with the author's interpretation of one of these as "bilateral subluxation." In this, the acetabulum has a steep slope—what many American radiologists would designate as a "pre-luxation stage"—but the heads are certainly not out of the acetabula.

In cases which do not easily lend themselves to closed reduction, the shelf operation is considered the procedure of choice.

PERCY J. DELANO, M.D.

## THE GENITO-URINARY SYSTEM

**Use of the Antidiuretic Property of Pitressin in Excretory Pyelography.** Robert Lich, Jr., and Paul J. Lewis. *J. Urol.* 54: 400-402, October 1945.

The preparation of patients for intravenous urography can be reduced to a minimum by administering pitressin in doses of 0.5 c.c. (10 units) subcutaneously

twenty minutes before the intravenous injection of the contrast medium. The patients are denied neither food nor drink. A satisfactory concentration of urine results, due to the reabsorption of water in the renal tubules. The absence of undesirable reactions is attributed to the small dose and the fact that the patients are not starved and not dehydrated. Pregnancy is a contraindication.

J. L. BOYER, M.D.

**Unilateral Triplication of the Ureter and Renal Pelvis.** John T. MacLean and E. W. Harding. *J. Urol.* 54: 381-384, October 1945.

Only three authentic cases of unilateral triplication of the ureter and renal pelvis are on record. A double or triple ureter results from the development of more than one ureteric bud from the wolffian duct. In the case reported here, two of the ureters fused just prior to entrance into the bladder. It is probable that the third ureter arose as an outpouching of the second ureteric bud. The patient was a man of 41, complaining of pain in the left lumbar region after an attack of pneumonia. Intravenous and retrograde pyelography revealed the developmental anomaly. ALTON S. HANSEN, M.D.

**Congenital Valve in the Upper Ureter.** John T. MacLean. *J. Urol.* 54: 374-380, October 1945.

Ureteral valves of congenital origin at the sites of normal ureteral narrowing are said to be present in 20 per cent of all persons. Valves in the upper ureter, however, are extremely rare. The author mentions Eisendrath, Hunner, Gottlieb, and Campbell as having reported cases of upper ureteral valves, and he himself presents a case. The valve was in the right ureter at the junction of the middle and upper thirds. The patient gave a childhood history of enuresis, but except for this had experienced no urinary symptoms until he was twenty-six years old. At that time frequency, dysuria, and pain developed. The roentgen findings were those of hydronephrosis, with apparent obstruction at the ureteropelvic junction and dilatation of the upper end of the right ureter. The valve was removed surgically and the patient, a sailor, returned to active sea duty two and a half months after operation with definite improvement, though not complete disappearance, of the hydronephrosis. Preoperative and postoperative pyelograms and ureterograms are reproduced.

JAMES C. KATTERJOHN, M.D.

## RADIOTHERAPY

### NEOPLASMS

**Transitional Epithelial Cell Carcinoma of the Nasopharynx.** J. E. Whiteleather. *Am. J. Roentgenol.* 54: 357-369, October 1945.

Sixteen cases of transitional epithelial-cell carcinoma of the nasopharynx observed and treated during the five-year period between 1937 and 1942 form the basis of this report. This type of tumor has been the most common one in this location in the author's experience. A review of the literature on the historical aspects and the pathology of the lesion is given. Clinically, diagnosis often is difficult even when the disease has reached an advanced stage. Direct visualization of the tumor may require repeated nasopharyngeal examinations. Lateral and mentovertebral roentgenograms of the nasopharynx may be helpful in showing luminal defects on the posterior and lateral walls. Symptoms are extremely variable and include deafness, double vision, "sinus aches," and the like. A unilateral compression of the eustachian tube occurred early in the disease in 12 cases. This is usually a minor symptom and is manifested as a clicking sound or a roaring in the ear. Cervical adenopathy was the next most common finding. Cranial nerve involvement was present in 9 cases, the fifth nerve being most frequently affected.

In treatment radiation therapy is the method of choice, as adequate surgery is impossible. The method of treatment is outlined in detail.

L. W. PAUL, M.D.

**Adamantinomas of the Jaw, with Reference Especially to Their Treatment.** Karen Lübschitz. *Acta radiol.* 26: 441-455, Aug. 31, 1945. (In English.)

A review is given of the history, location, morphology, and histologic appearance of adamantinomas, and the etiologic relationship between that tumor and the enamel organ is discussed. Adamantinomas are, as a rule, considered benign, although malignant examples have been recorded.

Eleven adamantinomas were seen at the Radium Center in Copenhagen in the years 1932-43, the diagnosis being established by roentgen examination and biopsy. Seven of the tumors were in the upper jaw and 4 in the lower. This distribution differs from that usually found, but is explained on the basis of the small number of cases. In the mandible, the roentgenographic picture shows a well defined area of rarefaction or several such areas more or less confluent. In the maxilla, the picture is less characteristic. The only early sign may be the haziness of the maxillary sinuses, and not until later do signs of bone destruction appear. Biopsy is necessary for a definite diagnosis.

The treatment of the cases reported here was partly surgical and partly roentgenological, but the author stresses the fact that surgery is the only effective method of therapy. The most efficacious surgical method is complete resection of the portion of the bone in which the tumor is present, for though these tumors are histologically benign, they may be clinically malignant. Occasionally, a well circumscribed solid tumor may be enucleated. Radiation therapy has practically no effect and should be used only as a palliative measure in far advanced cases.

J. H. WEISS, M.D.

**Direct Irradiation of Cancer of the Stomach and Other Viscera Exposed Temporarily at Operation.** G. Cranston Fairchild and Alan Shorter. *Lancet* 2: 522-526, Oct. 27, 1945.

Because of the failures of surgery, external irradiation, radon seed implantation, and intracavitary irradiation in gastric cancer, the authors have devised a method of combined surgery and direct irradiation. During the past eighteen months they have used this procedure in 15 cases of inoperable visceral cancer. In 6 of these cases (cancer of the stomach 3, esophagus 2, colon 1), the lesion had spread beyond the possible field of irradiation and little beneficial effect was achieved. Details and results of treatment are given in the other 9 cases (cancer of the stomach 6, abdominal esophagus 1,

pancreas 1, colon 1). All of the patients were bad risks for any operative procedure and would have died within a few months at most if untreated. At the time of the report 5 were doing well at over eighteen, fifteen, fifteen, seven, and five months after combined operation and irradiation.

Although the series is small, the authors believe the results show that their method is a rational and hopeful advance in the treatment of inoperable cancer of the viscera. While wider exposure is needed than for surgery alone, the whole procedure, with adequate precautions, should be less shock-producing than wide surgical excision.

Having no precedent to indicate the effects of high tumor doses within a minimum of 2-5 min., rather smaller doses than could be expected to be curative alone were given to the earlier cases, and supplementary external irradiation was started ten days following operation. At first only one x-ray tube (a Metropolitan Vickers constantly evacuated tube of the 250 kv. type) was used; now two tubes are employed simultaneously in treating a single lesion. This has been done to increase the lesion intensity to double that available with the standard apparatus. The lower tube has a vertical traverse only, whereas the overhead tube has a vertical and horizontal traverse. With the single tube, the total initial lesion dose through the wound has been 500-1,200 r, the latter figure being chosen in the earlier cases because it had proved effective in certain superficial lesions. With the two tubes, a provisional figure of 1,300 r was decided on as a minimal dose throughout the tumor, entailing a surface dose of 1,350 r from each tube simultaneously. Even after a dose of 1,500 r in about three minutes there was remarkably little reaction. Such reaction as did occur came on later, when the operative shock had passed off, and was limited to slight nausea and anorexia, with rare vomiting. The radiation reaction was more severe and the recovery much slower in the patients who received external irradiation.

**Qualitative and Quantitative Histological Examination of Biopsy Material from Patients Treated by Radiation for Carcinoma of the Cervix Uteri.** A. Glücksmann and F. G. Spear. *Brit. J. Radiol.* 18: 313-322, October 1945.

Glücksmann in 1941 described a method of evaluating quantitatively the results of radiation on human malignant tissue by serial biopsies during treatment (*Brit. J. Radiol.* 14: 187, 1941. *Abst. in Radiology* 38: 125, 1942). This makes possible an earlier prognosis in individual cases and more rapid evaluation of methods of irradiation than waiting for the customary three- and five-year periods. This method was applied to 166 patients with carcinoma of the cervix treated since 1938 by some modification of the Stockholm technic. A further series of 502 cases treated between 1930 and 1939 was classified on the basis of a pre-irradiation biopsy, according to the degree of anaplasia, and the results were compared with the clinical follow-up, which covered at least five years.

The method consists in classifying the entire cell population of selected young areas from the primary tumor in serial biopsies done before, during, and after treatment. It is important to select young areas from the growing edge. The cells are placed in four categories: dividing, degenerating, resting, and differentiat-

ing. By plotting these counts as percentages against time on a graph, curves are obtained which indicate the effectiveness of the irradiation.

Many biopsies were made in the original studies. In practice, it was found that four, at 0 (pre-irradiation), 7, 14, and 28 days after the first irradiation, were sufficient for a reliable assessment of the histologic response.

An unfavorable response is characterized by a persistence of mitosis, little or no alteration in the resting and degenerating cells, and no increase in the number of differentiating cells. A favorable response is indicated by an early disappearance of mitosis, a later disappearance of resting cells, and an increase in the degenerating and differentiating cells. Eventually there is a fall in the differentiating cell count corresponding to an increase in the degenerating cell count.

In the majority of cases there is agreement between the histological and the clinical observations. The main cause of disagreement, which appears in the early months after treatment, is the absence of clinically recognizable cancer when there is evidence histologically of malignant growth. During this period, apparent healing does not necessarily mean absence of malignant cells. The percentage of disagreement between histological prediction and clinical observation decreases with the passage of time.

In this series, on the basis of the pre-treatment biopsies, the tumors were classified as "anaplastic parakeratotic," showing practically no signs of differentiation; "anaplastic squamous," with cells resembling young normal basal cells; and "anaplastic columnar," showing adenocarcinomatous characteristics. The anaplastic parakeratotic tumors show a less satisfactory response than tumors of the other two groups in the same stages, but this is not uniformly consistent, indicating that other factors than histologic classification play a part.

Other factors which may influence the outcome may be uncontrollable variations in the distribution of the radiation in spite of every effort to keep it standardized. There may be unrecognized tumor cells outside of the area irradiated, or distant metastases, or unfavorable factors in the surrounding tissues.

The survey of the 502 cases which have a five-year follow up confirms the fact that irradiation is less satisfactory in anaplastic tumors than in differentiating types.

SYDNEY J. HAWLEY, M.D.

**Carcinoma of the Female Urethra (Review of the Literature and Report of Three Cases).** S. G. Clayton. *J. Obst. & Gynaec. Brit. Emp.* 52: 508-512, October 1945.

Three cases of carcinoma of the urethra in women are reported. One patient remained well for two years following excision of the cancer and implantation of radon seeds, but was then lost trace of. Excision of the tumor and implantation of radon seeds was carried out in the second woman, aged 70, but in view of her age and condition, inguinal dissection was not performed. She remained well for three years, at the end of which time a local recurrence appeared. She was treated with x-rays and implantation of radon seeds, with no evidence of recurrence at the date of the report (four years after the operation). The third patient, aged 82, was gravely ill on admission to the hospital. The bladder was distended up to the umbilicus and attempts to pass a catheter failed because the distal urethra was surrounded by a submucous induration, which extended

beneath the intact vaginal epithelium. Suprapubic drainage was established and a part of the growth was excised for section. Fifty milligrams of radium in a flat container with filtration equivalent to 3 mm. of lead was applied to the anterior vaginal wall and vestibule for forty-eight hours on two occasions. The growth retrogressed so that a catheter could be passed, but the patient's general condition failed to improve and she died a month later.

The literature is reviewed briefly.

**Some Remarks on Giant-Cell Tumors and Their Treatment by Radiotherapy Considered Over a Long Period.** F. Baclesse. *J. de radiol. et d'électrol.* 26: 41-46, 1944-45.

The author begins with the general statement that giant-cell tumors are in the benign group but show a marked tendency to growth when partially destroyed by either surgery or radiation. If treated by surgery, they should be completely extirpated, though this sometimes necessitates amputation or disarticulation; if radiation therapy is used, the dosage should be adequate.

One term used by the author impressed the abstractor as original and descriptive, namely, *poussée ostéolytique*, or "osteolytic thrust." By this is meant growth of the tumor by a peripheral advance of osteolysis, followed by a period of recalcification, so that a zone of osteolysis may be rimmed by a zone of increased density, or the two processes may appear successively. This phenomenon of osteolysis followed by calcification may take place three or four times in a period of eight or ten or twelve years, producing an effect described as an "accordion-like tumor," which is shown in the illustrations accompanying the text.

Attention is called to the impression of sarcomatous degeneration sometimes gained on viewing a film made during an osteolytic episode; radiotherapy vigorously undertaken at such a time may soon rule out sarcoma by initiating the calcific phase.

Successive films of two cases are reproduced, a tumor of the lower end of the radius and one of the upper end of the humerus. Both tumors were large and were followed over long periods: the end-results in each were declared good from the functional standpoint, a firm zone of calcification enclosing the tumor in each instance.

Twenty cases irradiated over a period extending from 1920 to 1933 are reviewed.

The caution is given that the rate of growth of the tumor, as well as its tendency to osteolytic episodes, must be observed and taken into consideration, so that if it appears that operation will ultimately be inevitable, too much skin damage may not have been sustained in the surgical field.

PERCY J. DELANO, M.D.

**An Unusual Case of Hodgkin's Disease. Second Report.** John W. Avery and J. W. Warren. *Arch. Ophth.* 34: 318, October 1945.

In 1941 (*Arch. Ophth.* 26: 1019, 1941), the authors presented a case of Hodgkin's disease involving the lymphatics of the bulbar conjunctiva of both globes, as well as various lymph nodes elsewhere in the body. In May and June 1940, the patient was given fifteen roentgen treatments to the eyes, the left cheek, the two sides of the neck, and the groins (a total of 3,000 r, of which 1,400 r was directed to the eyes). In November

and December of the same year, a second series of ten treatments (2,000 r) was given, distributed as before except that none was given to the eyes. Ten days after the first roentgen treatment the ocular lymphoid growths were thinner and somewhat bleached. Improvement was general and constant. On Nov. 15, 1941, the globes were entirely free from lymphoid tissue, the sclerae being white. The vision was normal.

In the present report, the authors bring the case up-to-date. In 1942 no treatments were given. In May and June 1943, ten roentgen treatments were given to the somatic nodes only (amount not stated). There has never been the slightest tendency to a recurrence of the lymphatic involvement of the bulbar conjunctivae. The eyes seem clear. There is still a small residual lump in the left cheek, but no palpable enlargement of the superficial lymph nodes in the groins, axillae, and elbows. The spleen does not appear to be enlarged.

### NON-NEOPLASTIC DISEASE

**Monel Metal Radium Applicator Designed for Maximum Use of Hard Beta Rays in the Treatment of Nasopharyngeal Hyperplastic Lymphoid Tissue.** Curtis F. Burnam and Samuel J. Crowe. *Mississippi Valley M. J.* 67: 109-111, October 1945.

**Radium Treatment of Hyperplastic Lymphoid Tissue in the Nasopharynx.** Gilbert E. Fisher. *Ibid.* pp. 112-115.

**Radium Therapy in Benign Nasopharyngeal Pathology (Use of the Radium Applicator Devised by Burnam and Crowe).** Harold Swanberg. *Ibid.* pp. 118-119.

The three papers listed above are devoted to the radium therapy of benign nasopharyngeal lesions by means of a new applicator designed by Burnam and Crowe. The essential feature of the applicator is a monel metal chamber, 15 mm. long, with an inside diameter of 1.7 mm. and a wall thickness of 0.3 mm., attached to a semi-flexible handle. The chamber holds 50 mg. of radium and the thin wall of the capsule allows the emission of a sufficient volume of beta rays so that treatment can be given rapidly—eight and a half minutes per area irradiated. As a rule, three applications at twenty-five-day intervals are adequate for the treatment of hyperplastic lymphoid tissue, but four or five may sometimes be required. The method is easy and painless (no anesthetic is required); it is without ill effects and entails no loss of time from the patient's work.

Fisher reports good results in deafness, particularly in children, associated with malfunction of the eustachian tubes; recurrent acute upper respiratory infections, especially those beginning with irritation in the nasopharyngeal lymphoid tissue; recurring attacks of otitis media; bronchial asthma, particularly in children; aero-otitis; selected cases of tinnitus and vertigo; and chronic obstruction of the posterior nares in children. His failures (about 11 per cent) he attributes to an insufficient number of treatments.

To the advantages mentioned above, Swanberg adds the economy of the method, giving details as to the rental cost of radium and rental and purchase cost of the applicator. He appends a comprehensive bibliography.

The remainder of this issue of the *Mississippi Valley Medical Journal* is made up of abstracts of papers published elsewhere dealing chiefly with the use of radium in otolaryngologic practice.

**Indications and Statistics on the Radiation Treatment of Utero-Adnexal Tuberculosis and of Tuberculous Peritonitis with Genital Lesions.** R. Mathey-Cornat. *J. de radiol. et d'électrol.* 26: 52-55, 1944-45.

The author reports a series of 160 cases of peritoneal and genital tuberculosis in the female, about half of which were treated by actinotherapy and heliotherapy, while the other half were given radiotherapy. He discusses the treatment in relation to the relative advancement of the peritoneal process, degree of visceral involvement, age of the patient, and response to medical and surgical measures. The classification on these bases is rather elaborate and none too clear; and several points as to the general management of patients with peritoneal tuberculosis may be called into question.

For one thing, in patients not making satisfactory progress, and in whom the diagnosis of salpingitis or oöphoritis of tuberculous origin has been established, roentgen sterilization is advocated. Actually the rationale of this procedure is not understood, and its benefits may be questioned.

A rather large group, not too advanced, are selected for actinotherapy; this has always had a vogue, but its merit, *per se*, has not been established. Certain procedures have always been conceded an empiric status in the treatment of tuberculous peritonitis; sun-ray exposure is one of them, and surgical opening of the abdomen is another. The real fact of the matter is, and is now understood to be, that tuberculous peritonitis, unless complicated by the involvement of some viscera which establish their own obstacles to cure, is a relatively benign condition which in the great majority of instances goes on to recovery; rest is the prime essential in treatment and is aided by all measures that fortify the patient's resistance. The value of exploratory laparotomy is questioned by most authorities, as is the value of any form of radiant energy. Certainly, in those cases which are progressing satisfactorily after removal of one tube or ovary, roentgen exposure should not be considered; any value which might accrue from its use would not serve to compensate for the sterilization which must accompany the treatment.

It is noteworthy here that the author states that the more severe the peritoneal process, the lighter should be the x-ray exposure.

PERCY J. DELANO, M.D.

**Ankylosing Spondylitis. Symposium.** H. Wyatt, R. McWhirter, and Hernaman Johnson. *Brit. J. Radiol.* 18: 301-308, October 1945.

Following some introductory remarks by Wyatt, McWhirter presents a general discussion of ankylosing spondylitis of the Marie-Strümpell type. Clinical and radiological descriptions usually refer to advanced disease. Since, however, little or nothing can be done in the late stages, the early recognition and treatment are all-important. The onset is usually in the third decade, and males are predominantly affected. In a series of 168 cases, 91 per cent were males, and their average age at onset was twenty-six years. The cause is unknown. The rate of development varies from a few months to many years.

The first symptoms consist of fleeting pains in the back and hips, gradually becoming more constant and localizing in the lumbar region. On flexion the erector spinae muscles stand out prominently. There is tenderness over the sacroiliac joints and sometimes along the crests of the ilia. Chest expansion is restricted. The

patient looks toxic, and the sedimentation rate is raised.

The first x-ray findings are blurring and irregular destruction of the sacroiliac joints with sclerosis of the adjacent bone. The spine at this stage may show no abnormalities. Only later is the "bamboo" spine demonstrable, with fixation of the hip and shoulder joints. As the disease advances, the posterior articulations of the spine are narrowed and indistinct and the margins of the vertebral bodies become sharp. Still later the anterior and lateral ligaments are ossified.

The first stage in the treatment is x-ray therapy. Treatment is given over the sacroiliac joints and the entire spine. A total of 2,500 r (whether in air or with back-scatter is not specified) generated at 250 kv., with 1 mm. steel filter, is given in divided daily doses within two weeks. Irradiation relieves the pain and stiffness, but prolonged orthopedic treatment is an essential part of the management. The relief of pain produced by irradiation makes possible more effective exercise and massage.

Hernaman Johnson discusses the prognosis of spondylitis in relation to treatment. As regards capacity to earn a living he finds the prognosis good. One paragraph from his paper may be quoted in full:

"Let us suppose then, that by some form of x-ray treatment we have made a patient symptom-free. What are his chances of so remaining? In early cases, when there is no loss of mobility but only pain, and where there are only slight radiographic changes confined to the sacroiliac joints, the prospects of a long remission extending into years are good. I have had one patient under observation for fourteen years, with no sign of relapse. Several young men treated in the years immediately preceding the war have since joined the Services. Some have been invalidated; others remain fit for duty. A common experience at the Charterhouse Clinic is for a man to turn up after four or five years, stating that he has been quite well during all this time but has lately had a return of pain. He believes that 'a few treatments will put him right.' One looks up his record, and finds that, let us say, his pain had all disappeared within three months under x-ray treatment, and had, indeed, mostly gone in a matter of weeks. The patient is full of confidence; he expects this miracle to be repeated, and sometimes it is. But by no means always. His blood should be examined and any anemia combated. Then, the previous treatment may be tried, but if it does not seem to be effective, no good can come from pushing it."

SYDNEY J. HAWLEY, M. D.

**Eosinophilic Granuloma of Bone.** Paul Michael and Nathan C. Norcross. *U. S. Nav. M. Bull.* 45: 661-668, October 1945.

The cause of eosinophilic granuloma of bone is still in question but its incidence is higher than previously suspected. The authors describe it as a benign destructive lesion affecting principally the skeletal system, with a predilection for the ribs and skull [to which he might have added the pelvis]. It is no longer considered a solitary lesion but rather frequently affects multiple osseous areas. The histologic picture is unusual, revealing large accumulations of histiocytes, eosinophilic cells, leukocytes, and giant cells. These last are probably of two types, phagocytizing and osteoclastic. Roentgenograms are suggestive but not diagnostic. The interior of the bone is primarily involved, while the cortex is expanded and frequently eroded. The

condition is practically limited to children and young adults, especially males.

Surgical treatment is most desirable, as biopsy proof of the disease is achieved at the time the lesion is removed. X-ray therapy is also beneficial. Spontaneous healing is known to occur. There may be a relatively long interval between the recognition and treatment of the initial lesion and the appearance of subsequent lesions.

The authors present two cases with fairly good photomicrographs. In one patient, a 25-year-old man, the lesion, measuring  $1.8 \times 1.2$  cm., involved the right temporal region. Excision was sufficient therapy. The second case was in a 21-year-old man, and the site was the region of the 8th and 10th thoracic vertebrae, with production of a transverse myelitis. After biopsy, 2,242 r [no other factors given] were given to the area; three months later neurologic symptoms had largely disappeared and the patient was able to walk without difficulty.

SYDNEY F. THOMAS, M.D.

## TECHNIC

**The Chaoul Method and Classical Superficial Radiotherapy. A Study of Absorption Curves.** Jean Calvet and P. Marquès. *J. de radiol. et d'électrol.* 26: 55-59, 1944-45.

The tube utilized in the Chaoul technic follows essentially the lines of Coolidge tube construction, with a filtration equivalent to 0.2 mm. of nickel; the kilovoltage is about 60, and the milliamperage about 3. A table shows the coefficients of transmission in water in percentage of the incident dose and includes similar observations for five other tubes. These coefficients are also presented in the form of plotted curves.

Chaoul radiation at 60 kv. is slightly harder than the so-called classical soft radiation at 100 kv., unfiltered. The real advantage of the Chaoul tube is in the inclined anode, rather than in the physical qualities of the radiation emitted. Particularly is this anode of advantage in intra-cavity work.

PERCY J. DELANO, M.D.

## RADIATION EFFECTS

**Radiation Hazards in Medical Practice.** D. B. Harding. *Kentucky M. J.* 43: 228-231, September 1945.

This article is directed to those physicians who use x-ray and radium occasionally, who are apt to be less cognizant of the dangers inherent in the use of these modalities than are radiologists. A brief history of the development of x-rays and the experiences of the early pioneers with their frequently tragic results is given. The more recent improvements in equipment are noted, such as shock-proofing and lead protection of apparatus, so that the radiation is considerably more controlled than it previously was, but it is pointed out that this does not protect from over-exposure.

The author urges the use of as small a field as possible in fluoroscopic work and moving the patient about so that no particular part of the skin is over-exposed. He also emphasizes the need for keeping the hands of the operator out of the direct beam of radiation even though protecting gloves are worn. He warns against habitually calling upon some one person about the office to hold patients during radiography. He states that with the normal use of a radiographic machine in a general practitioner's office, lead protection is not usually necessary. If the operator will be careful to stand at a reasonable distance from the machine and never direct radiation at himself, he will not receive a sufficient amount of scattered radiation to do any harm.

The use of radium by the more or less uninitiated is still more dangerous than the use of x-rays, since the gamma rays of radium are so much more penetrating. Recommendations are made for the storage of radium and for the construction of a special table for the handling of radium applicators. The two most serious dangers are the danger of radium burn to the hands from the handling of applicators and the danger of production of anemia or leukemia. March's figures (*Radiology* 43: 275, 1944), are quoted, indicating that leukemia is ten times as common among radiological physicians as among non-radiological physicians.

In conclusion, the author discusses the use of anesthetics and quotes Lundy's recommendation that only nitrous oxide and oxygen be used as volatile anesthetics

in the fluoroscopic room. He further recommends that a combination of avertin or intravenous anesthesia and nitrous oxide and oxygen is the most desirable method. He warns against the use of ether, cyclopropane, or ethyl chloride in the fluoroscopic room as exceedingly dangerous.

BERNARD S. KALAYJIAN, M.D.

**X-Ray Burns Resulting from Fluoroscopy of Gastro-Intestinal Tract.** L. H. Garland. *J. A. M. A.* 129: 419-421, Oct. 6, 1945.

The particular hazards associated with the use of the small portable x-ray unit when it is employed for fluoroscopy are emphasized in this article. During fluoroscopic examination of the gastro-intestinal tracts of four patients on the same day by a physician who was not a specialist, all of the patients received serious x-ray burns over their backs. The skin and underlying soft tissues in the affected areas were permanently damaged.

The author points out that if three factors, adequate distance, reasonable voltage, and low milliamperage, are borne in mind, the average fluoroscopist doing gastro-intestinal work is not likely to cause serious damage. The advisability of proper speed or dispatch in examination is also pointed out.

JOHN F. HOLT, M.D.  
(University of Michigan)

**Causes and Prevention of Radiotherapeutic Edema of the Larynx.** Benjamin Jolles. *Brit. J. Radiol.* 18: 278-283, September 1945.

The factors upsetting the normal equilibrium between the tissue spaces and the blood stream are manifold. Normally the capillaries act as semipermeable membranes. Dilatation of the capillaries may bring about increased permeability, and this may be sufficient to cause edema. Histamine and histamine-like substances also affect capillary permeability. A lowered plasma protein level in the blood or an increased protein content in the extracapillary spaces may affect the fluid balance.

A change in the sodium, calcium, and potassium ratio produces alterations in the water and salt exchange between the blood and tissue spaces. Calcium tends to

constrict capillaries and to make them impermeable, while potassium ions have the opposite effect.

Lymphatic and venous obstruction, when sufficiently great to produce asphyxial damage to the capillary walls, may produce edema. Infection may exercise an influence through its action on the circulation and from substances liberated in the infected area. Certain structural peculiarities of the neck in relationship to the vessels and the connective tissues predispose to the production of edema in this region.

It can be assumed that when a large amount of cellular material, inflammatory or neoplastic, is being broken down, sufficient changes in the pH occur to be a significant factor. Decreased extravascular pressure may play a role in localized edema.

Edema of the glottis is really a misnomer. Studies by injection of fluids in ca lavers indicate that edema will first occur in the aryepiglottic fold, next in the glossoepiglottic fold, then the anterior surface of the epiglottis and the vallecula. The character and attachments of the connective tissues influence the distribution of the fluid. The reaction of the connective tissue is most probably alkaline under normal conditions. Acid causes swelling of the connective-tissue fibers and alkali produces swelling of the ground substance. The more acid or alkali that is added, the more water is attracted up to a certain maximum.

Under irradiation, capillary dilatation occurs from direct effect on the endothelium and indirectly from the production of dilator H substances. The arteries become constricted, decreasing the blood supply to the capillary endothelium. Slight swelling of the sub-endothelium contributes to the narrowing of the vascular lumen. An inflammatory reaction sets in, with diapedesis of leukocytes, and fibrin clusters form around the vessel walls.

The reversible changes which lead to edema sooner or later become irreversible. When lymphatic drainage is blocked, the amount of tissue fluid rises. This is intensified when infection, inflammation, and venous obstruction supervene. The tissue fluid becomes clotted, enmeshing cells in various stages of disintegration.

This material serves as a substrate comparable to that used in tissue cultures. This favors the growth of fibroblasts, which may enmesh viable tumor cells. Therefore, edema should be avoided if possible.

Gross edema is readily recognized, but beginning edema may present great difficulty. Early changes may be recognized by sagging of fluid in the nooks and crannies of the pharyngolaryngeal region, slight prominence of the aryepiglottic folds or the ventricular bands, blurring of the details in or around the growth, some degree of asymmetry between the two halves of the larynx, pain and immobility without or with fixation. Sometimes the evidences of early edema may be identified by soft-tissue radiography.

No single remedy can counteract all the various causes of edema. A mixed diet of adequate protein content is essential. Histamine and vitamin C should be tried. Foci of infection should be cleared up. Alkaline gargles are advantageous. Calcium gluconate, 10 per cent, may be given intravenously. The prevention of pain is of great importance. This may be accomplished by sprays of urethane, 1:6 in water with 1 per cent ephedrine and 1 per cent cocaine with a few drops of peppermint.

SYDNEY J. HAWLEY, M.D.

**Spontaneous Bilateral Fracture of the Neck of the Femur Following Irradiation.** Clarence H. Heyman. *J. Bone & Joint Surg.* 27: 674-678, October 1945.

A 60-year-old woman who was irradiated by x-rays and radium, for carcinoma of the cervix, complained of pain in the right hip fourteen months after completion of the treatment, but no abnormality was demonstrable radiographically. Eleven weeks later a roentgenogram showed a fracture in the right femoral neck, which was fixed with a Smith-Petersen nail. Three months later pain developed in the left hip and a fracture of the left femoral neck was found. This fracture was also nailed. The treatment proved effective in both instances and it is suggested as the procedure of choice in irradiation fracture of the femoral neck.

JOHN B. McANENY, M.D.

## EXPERIMENTAL STUDIES

**Hereditary Achondroplasia in the Rabbit. I. Physical Appearance and General Features.** Wade H. Brown and Louise Pearce. **II. Pathologic Aspects.** Louise Pearce and Wade H. Brown. **III. Genetic Aspects; General Considerations.** Louise Pearce and Wade H. Brown. *J. Exper. Med.* 82: 241-295, Oct. 1, 1945.

Hereditary achondroplasia in rabbits, characterized by size reduction and by a disproportion of bodily parts, most marked in the extremities, is described. The disease is incompatible with life. Only 11 of the 228 animals with the disease were alive when the litter was first examined, a few hours after birth; 5 of these survived only a few minutes, and 4 for six hours, while 2 are known to have lived at least twelve hours. The variation arose in pure bred Havana stock. The abnormality is determined by the expression of a simple recessive unit factor, affected individuals being homozygous for the factor. Females are somewhat more frequently affected than males, but the character is not

sex-linked. Rabbits heterozygous for the factor as determined by appropriate breeding tests have a perfectly normal appearance at birth and in later life.

In physical appearance and in the character of the skeletal changes, as shown by roentgenography, achondroplasia in the rabbit has a remarkable resemblance to the disease in man and in cattle and dogs.

**Investigation into the Time Factor in the Roentgen Irradiation of Cancer Cells: Protraction Experiments with a Transplantable Mouse Round-Cell Sarcoma and a Transplantable Mouse Carcinoma.** B. Refslund Poulsen. *Acta radiol.* 26: 463-483, Aug. 31, 1945. (In English.)

The purpose of the research done by the author was to investigate the time factor in the radiation of cancer cells. Since protraction offered the best experimental conditions, its effects were examined on two transplantable mouse tumors. One was a rapidly growing, sensitive, round-cell sarcoma; the other was a slowly

growing, resistant carcinoma (Krebs No. 2). Preliminary experiments established the statistical reliability of the new experimental method which was employed.

The protraction experiments were carried out with a so-called middle dose. This dose was found to be 1,160 r for the round-cell sarcoma and 1,600 r for carcinoma, at 175 kv, with filtration of 0.5 mm. Cu + 1.0 mm. Al. The tumors were irradiated at intensities of 58, 12.3, 3.3, and 1 r per minute. In the case of carcinoma, a steadily decreasing effect was found with increasing protraction. The percentage of takes fell about 20 per cent when the intensity was varied from 58 r to 1 r per minute. It was also found that the latent period was decreased when transplantation was made twenty-four hours after irradiation, as compared with immediate transplantation.

The round-cell sarcoma showed no essential change in effect when the intensity was varied from 58 r to 3.3 r per minute, but at 1 r per minute there was a definitely increased effect. Whereas the percentage of takes with the higher intensities varied from 43 to 48 per cent (when transplantation was done twenty-eight hours after irradiation was begun), it was only 5 per cent with an intensity of 1 r per minute. In other experiments, the percentage of takes at the two extremes differed by at least 25 per cent. A longer latent period was also produced.

Histologic changes in both tumors following irradiation are also described.

While the results show a definitely increased radiation effect in round-cell sarcoma with protraction, the author feels that the effect would probably again be decreased at a still lower intensity and believes that a critical intensity has been demonstrated. In the case of carcinoma, the decreasing effect with increased protraction is explained as an incomplete cumulation as a result of regeneration during irradiation. Two theories are advanced for the explanation of the critical intensity; one assumes a sensitive phase in the cell cycle, the other that irradiation produces an increased cell sensitivity.

J. H. WEISS, M.D.

**X-Ray Diffraction Studies on Fish Bones.** George C. Henny and Mona Spiegel-Adolf. *Am. J. Physiol.* 144: 632-636, Sept. 1, 1945.

For x-ray diffraction studies of bones the authors have found those of fish particularly well adapted.

They report such a study, including a comparison with mammalian bones.

**Eggs of the Bombyx-Mori as Material for Radiobiological Research.** J. P. Lamarque and C. Gros. *Brit. J. Radiol.* 18: 293-296, September 1945.

The eggs of the Bombyx-Mori (silkworm) are suitable for research because they are robust, easy to handle, and their radiosensitivity is in the range of human cells.

SYDNEY J. HAWLEY, M.D.

**The Synchrotron—A Proposed High Energy Particle Accelerator.** E. M. McMillan. *Phys. Rev.* 68: 143-144, September 1945.

**Radiation from a Group of Electrons Moving in a Circular Orbit.** E. M. McMillan. *Phys. Rev.* 68: 144-145, September 1945.

The author describes briefly in a letter to the editor a new type of accelerator to give 300-million-volt electrons. In a cyclotron a particle whose angular velocity is just right to match the accelerating frequency is in "phase stability," being pulled up if it lags and held back if it gets too far ahead. The equilibrium speed increases with the magnetic field and with the frequency. A group of electrons (or positive ions) can therefore be accelerated by increasing either of these gradually enough so that they never fall out of step. The similarity to a synchronous motor suggested the name, synchrotron. The magnet is of less size than for a cyclotron, because only a circular band is required, not the whole circular area of poleface. The magnetic flux needed is only about 1/5 that needed for an equal betatron. The author has calculated dimensions for a 300-million-electron-volt synchrotron which he is planning: magnetic flux (peak) 10,000 gauss, final radius of orbit 100 cm., frequency 48 megacycles per sec., injection energy (electron gun) 300 kv., initial radius of orbit 78 cm. Relativity effects do not put a ceiling on possible energies as they do for the cyclotron.

In a second communication the author calculates the energy lost by radiation by the whirling electrons in a synchrotron designed for 300 million volts. He finds radiation from a single electron 780 volts per turn, and for close groups of electrons, per electron, 1,400 volts per turn. This is thus no barrier to attaining the expected energies. (This effect is a serious one for the betatron and limits the energies attainable from such machines.)

R. R. NEWELL, M.D.



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